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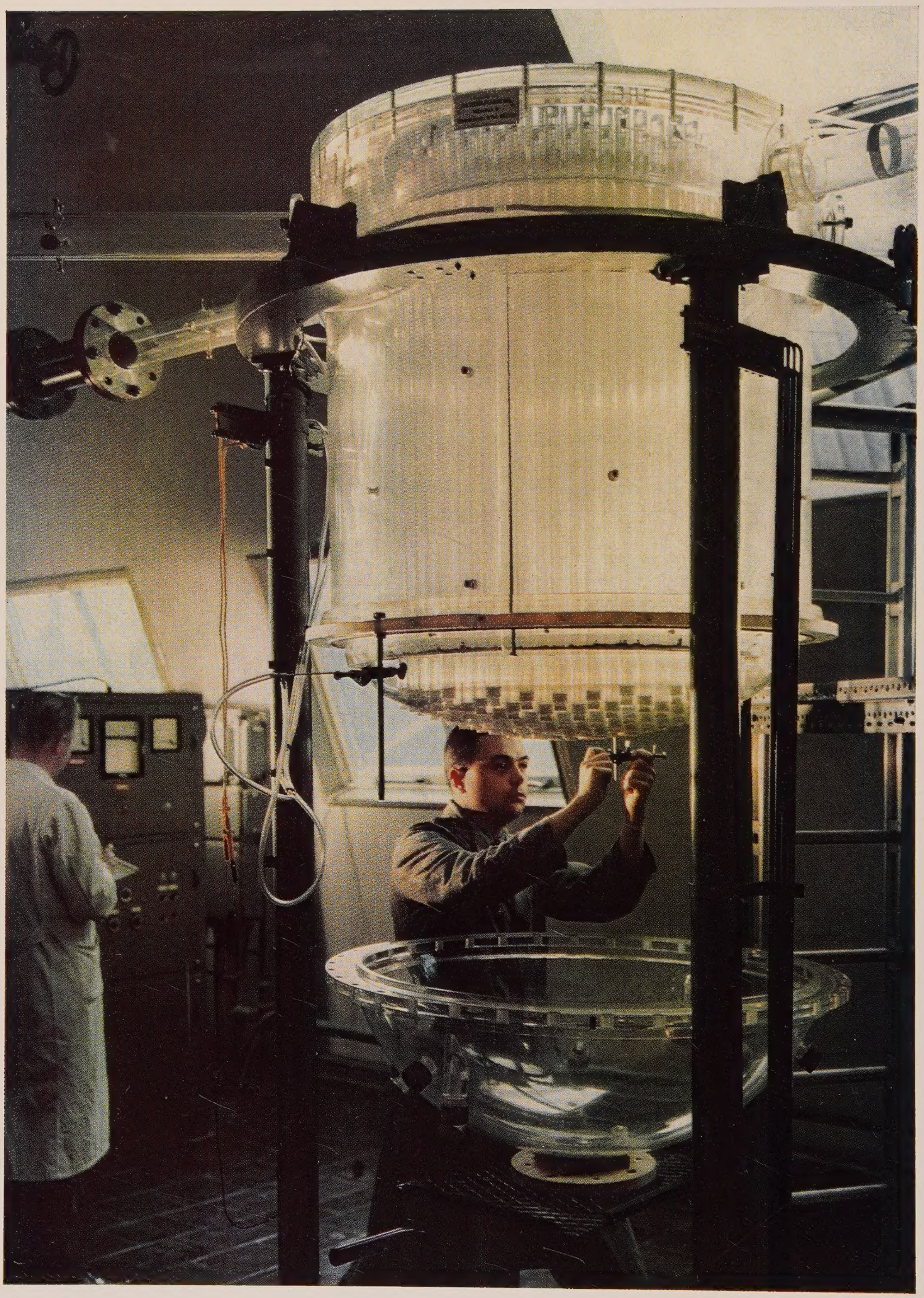

Model of the pressure vessel of the Siemens MZFR multi-purpose research reactor
This is used for carrying out flow experiments

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Standard Three-phase Induction Motors with "Increased-safety" Enclosures for Hazardous Locations

By Martin Reinhardt

I. E.C. Publication 72-1, 3rd edition (1959), contains recommendations for the main dimensions of motors and shaft extensions, as well as a range of output ratings for totally enclosed, fan-cooled three-phase squirrel-cage motors [1]. A great step towards the international standardization of electric motors has thus been accomplished.

I. E.C. Publication 72-1 specifies 35 different frame sizes with dimensions in millimetres, 18 sizes of shaft extensions (related to the maximum torque for continuous duty) and two series of output ratings, i.e., a "primary preferred series" comprising 25 values in metric h.p. and a "secondary preferred series" with 17 values in kW. The 35 frame sizes do not, however, differ in all their dimensions, some of the motors being combined in groups of which only the overall length is different; only 15 different values of shaft height are, therefore, included. The three largest models, for instance, are designated by the frame numbers 315 S, 315 M or 315 L. Each motor of these sizes has the same shaft height (315 mm), whereas the overall lengths are different (e.g., 406, 457 and 508 mm for the distance between centre lines of mounting holes in the side view). The remaining dimensions of the motors with frame number 315 are identical.

Unfortunately, it was not possible within the scope of I. E.C. activities to co-ordinate the frame sizes, shaft extensions and output ratings to create an international standard motor. This co-ordination was left to the National Committees among which endeavours are being made to obtain agreement on an international basis, e.g., between European countries.

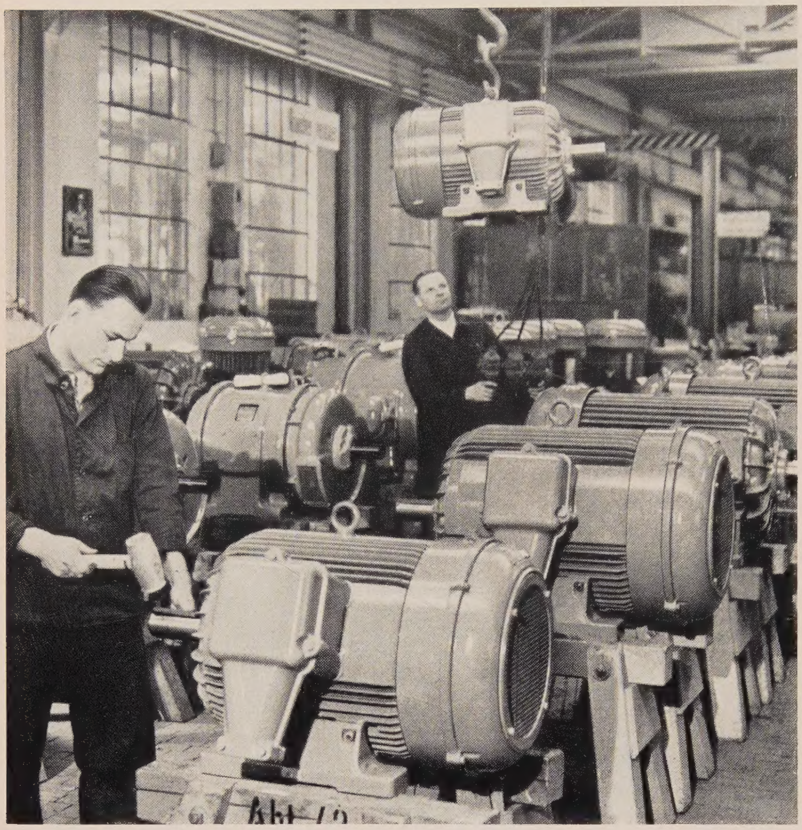
The German Standards Committee thereupon prepared a German Industrial Standard (DIN 42 673) for totally enclosed, fan-cooled three-phase squirrel-cage motors on the basis of the values recommended by I. E.C., in which the frame sizes, shaft extensions and output ratings are related to each other. This provided the basis for the German standard motor [2, 3].

The DIN Standard contains 23 of the frame sizes listed in I. E.C. Publication 72-1, and the selection made corresponds to that in the American NEMA Standards. Compared with the NEMA specifications, the output ratings were, however, selected higher in accordance with the German motor manufacturing practice.

Standard motors of "increased-safety" construction

In the chemical industry, oil refineries and petro-chemical plants in Germany, it is common practice to employ three-phase squirrel-cage motors in the "increased-safety" design (Ex) e for use in explosive atmospheres. Squirrel-cage motors of the "increased-safety" design to VDE 0171 are permitted for such applications, since these motors do not normally produce sparks or arcs which could ignite an explosive gas.

The protection against explosion afforded by these motors is attributable to the special measures taken to prevent the formation of sparks, arcs or dangerously high temperatures not only in normal operation but also under exceptional operational conditions. These measures consist essentially of the following:



Standard three-phase motors of the eOR 2 range in "increased-safety" design (motors shown at the front and on the crane) being prepared for shipment

Use of suitable materials, special attention being paid to details of manufacture

Compliance with more exacting requirements for insulating materials, clearances and creepage distances

Reduction of the maximum temperature rise of the insulated winding by 10 °C as compared with that permitted by VDE 0530/59 for normal motors

Special structural measures, such as the locking of all screwed joints to prevent their working loose, and improved protection against the ingress of foreign particles

Reduction of the temperatures of all parts to values which remain safely below the ignition temperature of the relevant gases and vapours, i.e., under locked-rotor conditions within the t_E time*; with the rotor locked, the protective breaker must disconnect the motor within the t_E time.

The motors of this design have been developed from the range of the normal motors, only slight modifications having been incorporated. An obvious further development was the creation of the standard motors in the "increased-safety" design (Ex) e. The relevant standard specifications are contained in DIN 42673, Blatt 2, for motors suitable for ignition-temperature group G 3.

"Increased-safety" type standard motors provide the same advantages as the normal standard motors, namely:

Uniform mounting dimensions as laid down in the Standard

Foundations, baseplates, mounting flanges and the mechanical transmission gear can be designed straightforwardly and economically

Replacement by spare motors, or of normal motors by "increased-safety" models, as well as stock keeping, is simple and economical.

DIN 42673, Blatt 2, covers standard motors in the design for explosive atmospheres for ratings between 1 and 120 kW for ignition-temperature groups G 1 and G 2, and with ratings from 1 to 100 kW for ignition-temperature group G 3 (4-pole models). The reduction of the maximum permissible temperature rise of the insulated parts by 10 °C as required by VDE 0171 and the adherence to the specified minimum t_E time necessitated reductions in the output ratings, i.e., by about 10% in the case of ignition-temperature groups G 1 and G 2, and by an average of 20 % with the motors for ignition-temperature group G 3. In general, therefore, different designs are used for the various ignition-temperature groups, an exception being the motors for groups G 1 and G 2. Small motors are also built for ignition-temperature

* "t_E" is the time within which the maximum permissible temperature is attained in the case of a short circuit or under locked-rotor conditions

groups higher than G 1 and G 2, the rating limit between identical and different designs becoming wider with increasing pole numbers and output ratings. Similar conditions prevail in the case of differing pole numbers. In the case of 2-pole motors, however, the output obtainable with a given size is somewhat lower, rising slightly as the number of poles increases.

The standard "increased-safety" motors of the eOR 2 range of Siemens-Schuckertwerke have been approved by the Physikalisch-Technische Bundesanstalt (Federal German Testing Laboratories) for ignition-temperature groups up to G 3.

The motors (see illustration) are built with enclosure (Ex) e – P 33 (totally enclosed) to DIN 40050; they are tropicalized and suitable for installation outdoors as well as in dusty and damp locations.

The frame, end shields and mounting feet are made of cast iron, which makes the motors highly resistant to corrosion by acids and alkalies. The rotor surface and inside surface of the stator are treated with an anti-corrosion agent. A quiet-running external fan effectively cools the ribbed frame surface, so that a uniform temperature gradient inside the motor is achieved. All motors have silent and smooth anti-friction bearings. The smaller motors (up to 45 kW at 1,500 r.p.m.) have prelubricated bearings, the larger ones regreasable bearings with a grease quantity regulator. The spacious and rugged terminal boxes with enclosure P 44 (hose-proof) are arranged in the centre of the frame and contain 6 supply-circuit terminals and at least one terminal for the protective (earth) conductor. All the terminals are designed for connecting the conductors without cable lugs. A further earth terminal is mounted on a foot.

Special importance was attached to a high-standard electrical design. In addition to the well-known technical advantages, the two-layer winding – as used with the conventional Siemens motors – affords good starting characteristics, due to the low harmonic content and the short and robust end turns. The insulation (varnish insulation of Class E) meets exacting requirements with respect to life and reliability, as has been proven by years of investigations and experience. Special attention was given to a satisfactory impregnation of the windings to prevent air inclusions and to make the winding resistant to vibration. The impregnating varnish has been approved by the Physikalisch-Technische Bundesanstalt for use in motors intended for hazardous locations.

The classification of the motor-torque characteristics according to several rotor types has also been retained for the standard motors. Rotor types KL 7, KL 10, KL 13 and KL 16 have been correlated to the various output and speed ranges, a method which is based on years of experience. The rotor designation KL 16 denotes that the motor, when started direct-on-line, is capable of accelerating reliably against a load torque equal to 160% of the rated torque; the same applies analogously to the remaining rotor types.

The standard motors in the "increased-safety" design of the eOR 2 range satisfy most of the requirements made for equipment to be used in explosive atmospheres. VDE 0165 prohibits the use of "increased-safety" motors only in locations where explosive gas-air mixtures are permanently present (e.g. in non-ventilated pump pits). For such applications, or where the standard specifications of other countries are to be complied with, flameproof three-phase motors are available [4].

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ELMO Compressors for High System Pressures

By Heinrich Engels

When the Siemens-Schuckertwerke applied for the patent rights of a very simple vacuum pump in 1905, the intention was to create a high-speed, direct-connected machine to be driven by the three-phase induction motors which were being introduced at that time. The method of operation of these vacuum pumps, which were also used as blowers, is best explained by the patent specification itself [1]: "Impeller pump with fixed-vane compressing element rotating excentrically in a drum-shaped casing, the vane tips dipping at periodically varying depth into a liquid ring produced by centrifugal force so that, with suitably located and designed inlet and discharge ports for the individual spaces formed by the blades of the compressing element, a displacement effect similar to that

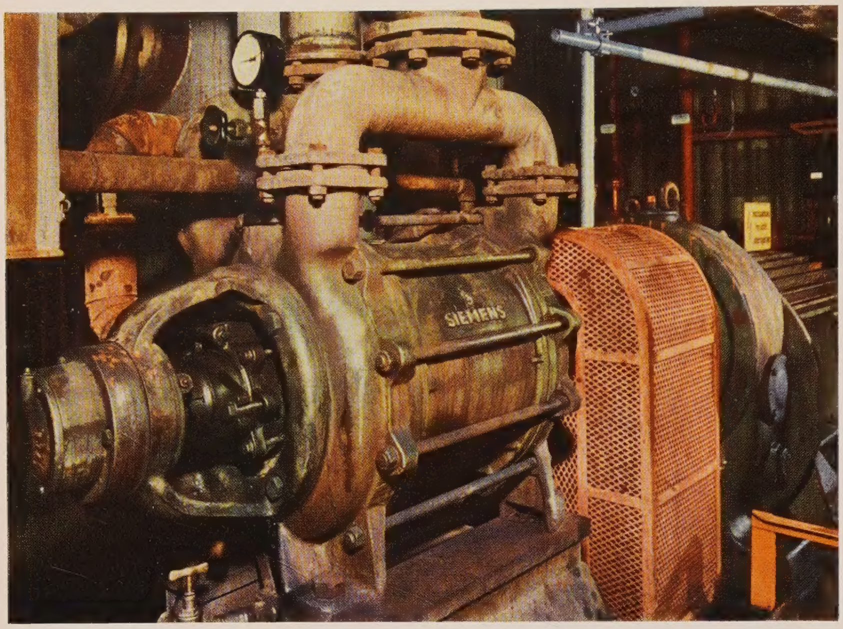

Fig. 1 Double-acting ELMO compressor for high system pressures in a chemical works. The maximum power input is 215 kW

of a piston pump takes place; characterized by a stationary casing within which the liquid ring revolves with the compressing element, making for a simple arrangement of the entire pump".

Under the name of ELMO* vacuum pumps and blowers, liquid-ring pumps of the type described soon found widespread application in the field of process engineering. The machines, which were originally designed for use as vacuum pumps, are also suitable for compressing gases from an initial intake pressure of 1 kg/cm² abs. to a final discharge pressure of 2 to 2.5 kg/cm² abs.

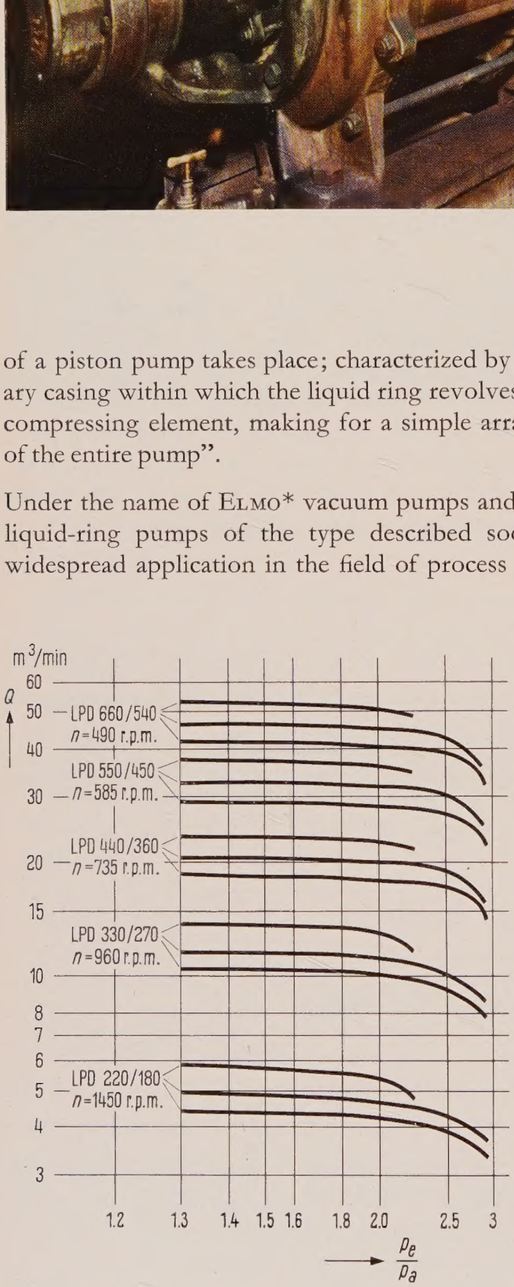

Fig. 2 Intake volume Q with double-acting ELMO compressors. Initial pressure 1 kg/cm² abs. (1 m³ = 35.3 ft³; 1 kg/cm² = 14.22 psi.)

Later, single-stage and two-stage compressor series were introduced in order to obtain higher discharge pressures [2]. In addition to these, there is a growing need in the chemical industry for compressors for handling gases to be circulated at an intake pressure of several atmospheres and compressed. This led to the development of liquid-ring compressors of the double-acting type (Fig. 1). These are of extremely rugged construction and can therefore be operated at high speeds up to an intake pressure of 4 kg/cm² abs. and a ratio of 3:1 between the final discharge pressure and the initial intake pressure.

The double-acting compressors are suitable for arduous service since their shafts are stressed only by the input torque [2]. This leads to no noticeable shaft deflection and the sealing of the stuffing boxes, which is not always very easy with high system pressures and the associated high shaft peripheral velocities, is considerably facilitated.

Double-acting ELMO compressors (LPD series), whose discharge capacities Q at 1 kg/cm² abs. inlet pressure and the associated asynchronous speeds n are listed in Fig. 2, are suitable for the majority of cases with elevated initial intake pressure p_a.

However, compressors of the LPD series cannot be used in all cases where, for processing reasons, liquid-ring

* Trade-mark

compressors would be preferred in the chemical industry. But in spite of this, progress made in the theoretical study of the problems associated with liquid-ring pumps has made it possible to meet even the most exceptional requirements by constructing special models.

Figs. 3 and 4 show the arrangement selected for compressing 24,000 Nm^3/hr of cracked gas from 8 to 16 kg/cm^2 abs. The two outer impellers 1a and 1b operate in parallel and compress the gas entering at a pressure of 8 kg/cm^2 abs. to about 11.3 kg/cm^2 abs. The gas thus compressed is then fed to the middle impeller 2 where it is brought up to the final discharge pressure of 16 kg/cm^2 abs. The centrifugal-pump impellers mounted at both ends between the shaft stuffing boxes and the gas pump are used to raise the water required for cooling and make-up purposes for the liquid rings to the pressure level of the compressor. The stuffing boxes are therefore exposed only to operating water of moderate pressure.

The input rating of the liquid-seal pumps has been raised in the course of time from the original fractions of a kW to about 200 kW. Approximately 1,300 kW are required to compress the above-mentioned 24,000 Nm^3/hr of gas from 8 to 16 kg/cm^2 abs. In order to reduce the risk involved in increasing the rating by 6.5 times (from 200 to 1,300 kW) for chemical processes which have not been tested on a large scale, a smaller compressor with a rating of about 420 kW has been constructed for the time being (see Fig. 3). The 1,300-kW compressor planned will not be constructed until sufficient experience has been gained with the 420-kW compressor in the handling of cracked gases which partly polymerize during the compression process.

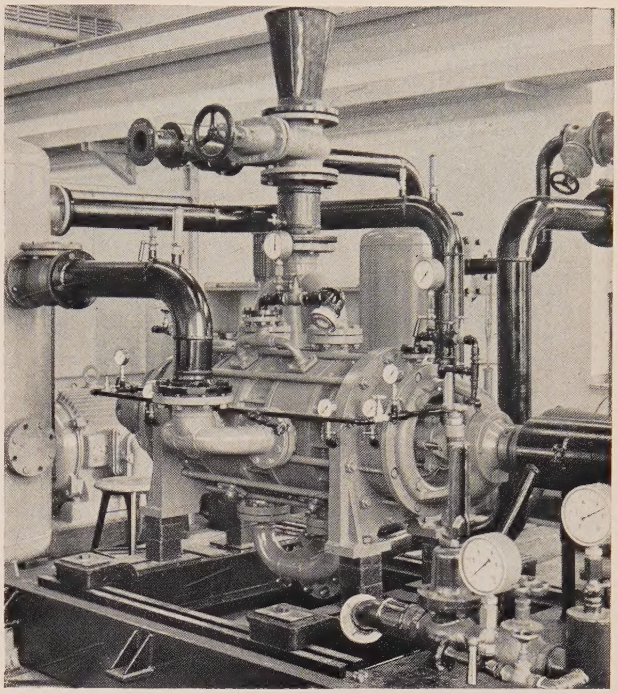

Fig. 3 420-kW cracked-gas compressor on the test stand.
The gas (8,000 Nm^3/hr) is compressed from the intake pressure of 8 kg/cm^2 abs. to the final discharge pressure of 16 kg/cm^2 abs.

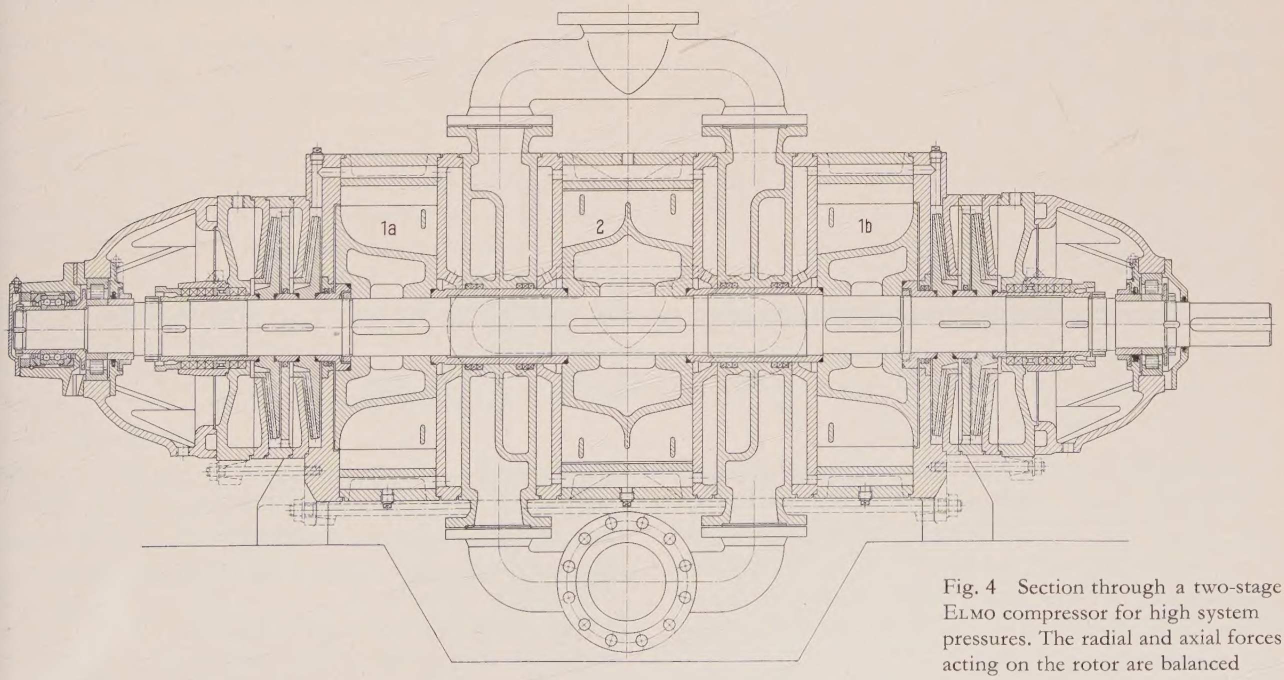

Fig. 4 Section through a two-stage ELMO compressor for high system pressures. The radial and axial forces acting on the rotor are balanced

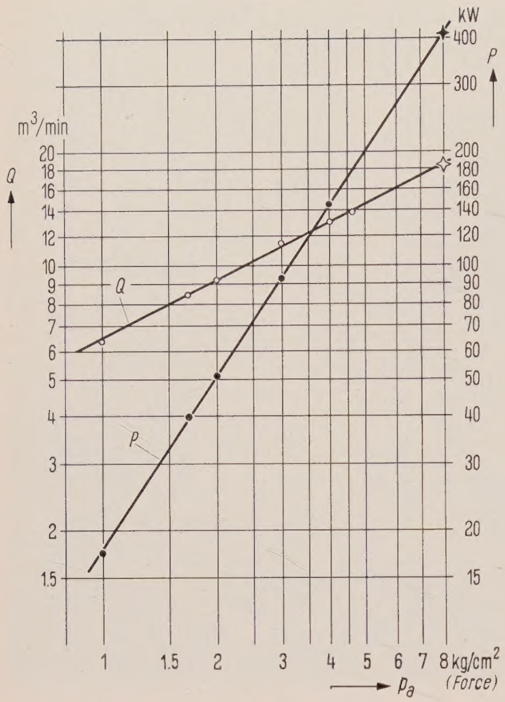

Fig. 5 Gas volume Q and power input P of the 420-kW cracked-gas compressor as functions of the intake pressure p_a. Confirmation of the law of dynamic similarity for liquid-ring gas pumps. (1 m³ = 35.3 ft³; 1 kg/cm² = 14.22 psi.)

The results of measurements carried out on the 420-kW compressor repeatedly confirmed the reliability of the dynamic similarity law [2, 3] with respect to liquid-ring pumps, although only the conditions of the thermodynamic similarity and of the Newton and Froude similarities together can be met, while the influence of the Reynolds number which was disregarded must be accounted for by correcting the efficiency.

The law of dynamic similarity states that all the compression phenomena are similar if

$$k = \frac{p \times 2\, g_n}{\gamma_n\, u^2} = \text{constant}$$

This also assumes that geometric similarity obtains and that the ratio between the final discharge and initial intake pressure of the gas is constant.

In the equation:

p Pressure (e.g. intake pressure) in kg/m²
γ_n Specific gravity of operating liquid in kg/m³
g_n Acceleration due to gravity in m/s²
u Peripheral velocity of impeller in m/s

The points plotted in Fig. 5 show that the intake capacity is proportional to $p_a^{1/2}$ if, on the one hand, the abovementioned value k is kept constant by setting the correct speed and, on the other, if the ratio between final discharge and initial intake pressure is also kept constant. Under the same conditions the power input P closely follows the expression expected in theory, namely:

$$P \sim p_a^{3/2}$$

There are no systematic deviations of the measured points from the theoretical potential function curves. Consequently, the simple law of dynamic similarity can be taken as a reliable guide in the designing of liquid-ring compressors and makes it possible to apply a model scale system where large compressors cannot be tested to full capacity on the test stand.

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Pressure Ratios and their Influence on the Design of ELMO Vacuum Pumps

By Gert Hecht and Kurt Willy Mugele

In the handling of wet, aggressive and explosive gases and vapours or such containing impurities, which must often be kept out of contact with oil, the process engineer is repeatedly faced with the problem of finding the most suitable compressing method. The method selected must ensure high reliability in operation with a minimum of maintenance and supervision.

Experience has shown that these requirements can be met by the Elmo* gas pump operating on the liquid-ring principle and such pumps are finding ever-increasing application, particularly in the chemical industry.
The simple construction and method of operation of Elmo gas pumps have been described in a previous

* Trade-mark

article[1]. The following deals with the influence of the pressure ratio p_e/p_a on the design of Elmo vacuum pumps and describes how the associated problems have been solved.

Intake pressures down to 110 Torr (Pressure ratio up to 7)

Particular importance is attached to the design of the discharge ports in the port plates which are designed for the minimum intake pressure economically obtainable. In order to prevent overcompression and losses due to turbulence in the case of high intake pressures, a few holes are drilled in the port plate to precede the sickle-shaped discharge port with respect to the direction of rotation of the impeller (Fig. 1). Of these holes the ones located within the zone of the discharge pressure permit the gas to flow through freely, while the water at the rear of the port plate seals off all the other holes which are still within a zone of low pressure. With this arrangement, therefore, the water provides a sort of valve effect the intensity of which can be estimated from the equation

$$\frac{Q_G}{Q_W} = \sqrt{\frac{\gamma_W}{\gamma_G}}$$

Where:

- Q_G Volume of gas flowing through hole
- Q_W Volume of water flowing through hole
- γ_W Density of the water
- γ_G Density of the gas

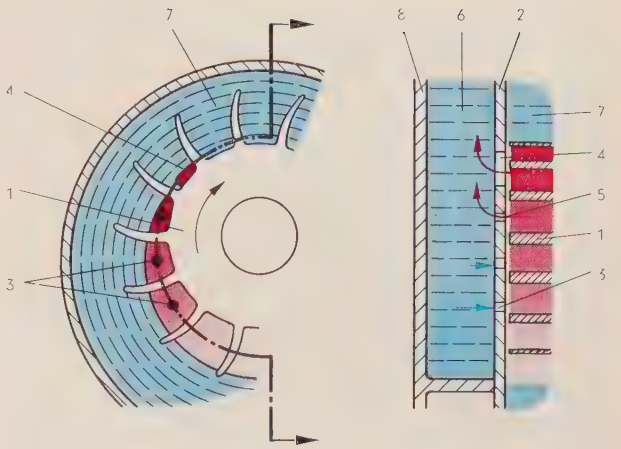
If one enters the values for water and air in the equation, approximately 30 times more air than water will flow through one hole at the same differential pressure.

Intake pressures down to 30 Torr (Pressure ratio up to 25)

In this range the valve effect of the water is no longer adequate. It would therefore seem practical to provide a second stage, thus retaining a pressure ratio of only about 5 in each stage. If one were to employ two-stage vacuum pumps, however, the advantage of the simple and robust single-stage construction, which has long given excellent results, would be lost. These important advantages include a reduction in the number of spares to be stocked, better inspection and installation facilities and smaller space requirements.

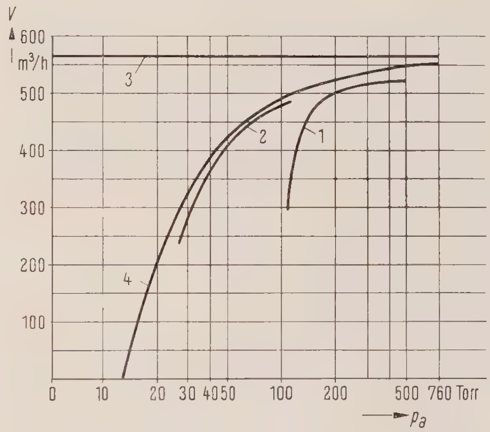
Studies have now been made to determine the best way to co-ordinate the various design variables, such as the construction of the impeller and casing and the form of the discharge and intake ports, in order to be able to

1 Schnapper, P.: Die Elmo-Gaspumpe und ihre Anwendung in der chemischen Industrie. Siemens-Zeitschrift **26** (1952) pp. 196 to 200



1 Impeller
2 Port plate
3 Holes in port plate
4 Sickle-shaped discharge port in the port plate
5 Gas handled
6 Working water between end plate and port plate
7 Water ring (working water in compression chamber)
8 End plate

Fig. 1 Water-valve effect in an Elmo vacuum pump for intake pressures of down to 110 Torr



1 Intake volume V_{a1} of an Elmo vacuum pump for initial intake pressures of down to 110 Torr

2 Intake volume V_{a2} of an Elmo vacuum pump with the same impeller dimensions and revolving speed as under 1 but for intake pressures of down to 30 Torr

3 Intake volume V_R determined by the impeller volume of the Elmo vacuum pump

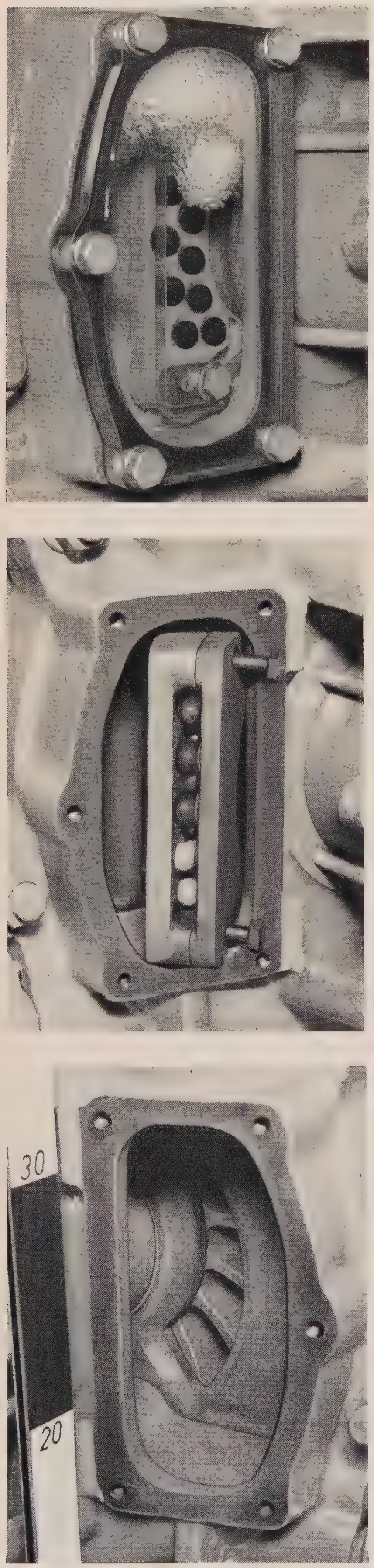
4 Physically possible intake volume V_{th} at a working-water temperature of 15 °C

$$V_{th} = V_R \frac{p_a - p_{d15}}{p_a} V_{R\varphi}$$

p_a Initial intake pressure in Torr

p_{d15} Vapour pressure in Torr at a working-water temperature of 15 °C

Fig. 2 Intake volume of an Elmo vacuum pump for 110 and 30 Torr. The intake volume of the 30-Torr vacuum pump is almost solely governed by the vapour pressure of the working water. (1 m³ = 35.3 ft³)



a Ball valves at an intake pressure of 45 Torr

b Model with ball valves accessible from the outside (Cover removed)

c The impeller etc. can be inspected after removing the cover

Fig. 3 Elmo vacuum pump of the latest design for initial intake pressures of down to 30 Torr

establish the desired pressure ratio of about 25 both reliably and economically in one single stage. Importance was also attached to the fact that such a pump should also be able to operate satisfactorily with smaller pressure ratios.

The research and development carried out in this connection yielded good results. As can be seen in Fig. 2, the intake volume of an Elmo single-stage vacuum pump for initial intake pressures of down to 30 Torr is now almost solely governed by the vapour pressure of the working water, i.e. volumetric efficiencies (V_{a2}/V_{th}) of near unity are obtained.

Another valuable contribution to this end has been made by developing further and employing the ball valve. Ball valves have given excellent service for many years even under the most arduous conditions. Their method of operation is illustrated in Fig. 3*a*. Since in this case the pump is operating with an intake pressure of about 45 Torr, the sickle-shaped discharge port in the port plates is no longer adequate for the compressed gas. The gas bubbles which can be seen in the illustration are a sign that one of the balls of the valve has been raised from its seat with the result that the gas can also flow out through the hole in the valve without becoming excessively compressed. With increasing intake pressures the other valve balls which can be seen further down are also raised from their seats, thus adapting the total discharge section to the pressure ratio.

On looking at illustration 3*a* one could gain the impression that the valves, and in particular the valve balls, are subject to a certain amount of wear and that they would therefore have to be replaced occasionally. In actual fact, however, if the intake pressure remains approximately constant, any wear on the balls will have no effect on the capacity or life of the Elmo vacuum pump. Many years of experience have also made it possible to select the most suitable valve material for each individual case.

Constant fluctuation of the intake pressure under severe operating conditions may lead to a certain amount of wear on the balls and consequently to a reduction in the capacity of the pump. However, in order to be able to deal also with such cases, the ball valves of the most recent Elmo vacuum pumps are accessible from the outside (Fig. 3*b*). After the cover has been removed, the valves can be readily taken out and replaced and inspection is also facilitated. Similar covers are also mounted over the intake ports. Once the cover has been removed, the parts inside can be quickly checked (Fig. 3*c*). It is therefore possible to inspect the impeller, port plates and centre unit and to measure the important gaps between the impeller and the port plates. These simple inspection features facilitate supervision of the pump in general and increase its operational reliability.

Hospital Press-to-Talk Intercom System

By Heinz-Günther Gillmeister

The press-to-talk intercom system permits direct voice intercommunication between patients and nursing personnel, so eliminating the need for nurses to walk all the way to the bedside of patients every time they send out a call signal.

The slave stations with microphone-loudspeaker are assigned either to the various beds or to single wards for the common use of all occupants. To call the nurse, all a patient has to do is press the button of a self-contained calling unit. The patient does not have to stand close to the station in order to talk, or even to touch it. This may also be an advantage from the standpoint of hygiene.

At the master station (Fig. 1) with its amplifier and relay assembly a nurse answers all calls as they arrive from patients. The master station is installed either in the nurses' room or in the tea-kitchen. Calls from patients can also be answered at additional answering stations installed in the various wards or the corridor (Fig. 2). The answering stations in the wards are designed so that any call can be accepted by actuating a common answering button. Patients incapable of talking can identify themselves by pressing a button which causes their respective room lamp to flash at certain intervals.

An emergency call circuit is provided so that, in cases of emergency, the nurse can make a call from a ward to the doctor in charge, the male nurse or some other assistant. The called party can ask questions over the same circuit.

The quietness of the ward is in no way disturbed by the intercom system because its excellent quality of speech reproduction makes it unnecessary to turn on the volume higher than required to permit, say, a low-voiced conversation between doctor and nurse. Whereas the volume of stations in wards is adjusted to a minimum – the amplifier power can, if necessary, be boosted by briefly pressing a button –, the nurse at the master station can adjust the volume of incoming calls as desired, e.g. for monitoring the breathing sounds of badly sick patients.

The intercom systems of several wards can be interconnected. This is particularly important at night when a single night nurse may have to take care of several wards.

Transistors and relays sealed tight against dust and gas insure the amplifier and relay assembly long service life and operating reliability. The intercom system can readily be supplemented by luminous call facilities.

Fig. 1 Master station with microphone and wall loudspeaker in nurses' room

Fig. 2 Slave station with separate calling unit installed in a ward; a nurse's answering station is seen in the background

ESK Translator for Direct Distance Dialing

BY WALTER VILLMANN

In direct distance dialing, translators process various sets of data representing, say, the area code, network configuration and sequence of connecting paths, to determine the information required for selecting a path to the wanted dial office (alternate routing) and fixing the charge for the call (zoning) [1]. Such a translator is taken into use only for a short time during the establishment of a call. As a single translator is usually able to meet the translation requirements of an entire dial office, it is therefore installed at a central location [2, 3].

Input and output operations are coded and take place so rapidly that a single translator is able to serve up to 1,000 input circuits, corresponding to about 30,000 translations in the busy hour, without subscribers having to wait for any perceptible period. As the high-speed noble-metal relay [4] is well capable of handling high calling rates of this order, this largely demechanized switching device was therefore used in constructing the highly economic ESK translator [5]. The lifetime of such relays, whose contacts operate without electric current, is extraordinarily long.

To prevent the processing of information at the DDD office from being interrupted even for a moment if the translator has to be disconnected for operational reasons or if its operation is stopped by external influences, it is common practice to install ESK translators in pairs. During regular operation, one translator then serves one half of the storages while the second translator serves the other half. If one translator breaks down, the other will, without any interruption of service, automatically take over the duty of serving all the storages. The two ESK translators are accommodated in a frame together with the access unit and supervisory, testing and recording equipment (Fig. 1).

From the area code, or part of the area code, of a wanted office, the ESK translator forms what are termed area-code points from which alternate routing and zoning criteria are derived (Fig. 2). Each area-code point represents, from the switching standpoint, an AND-circuit which becomes active only when the appropriate code is dialed.

The area-code points are realized through two contact pyramids and wired together with routing or zoning points which furnish the result in coded form by way of

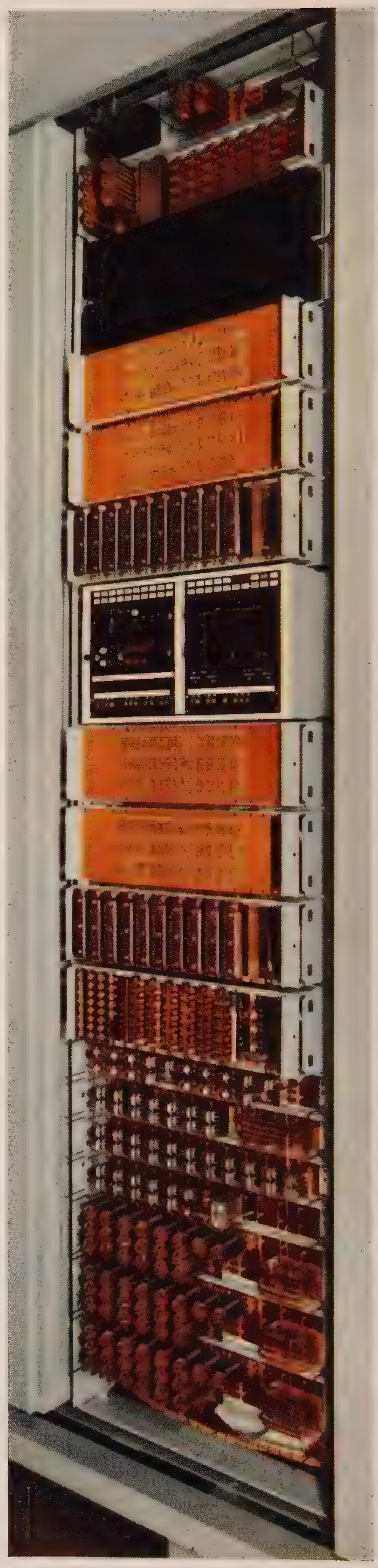


Fig. 1 Frame with pair of ESK translators

Top to bottom: fuses, access unit, translator 1, control panel, translator 2, supervisory and test equipment

rectifiers. All area-code points, routing points and zoning points are connected to jumpering frames inside the translator.

Translating operations

By dialing the code digit 0, the telephone user causes the seizure of a meter pulse generator which a relay finder connects to a free storage. The storage receives the area code of the dial office of the wanted party that is now dialed, e.g. 210, switches the ESK translator by way of the *f* contacts (Fig. 3) to the input circuits, and communicates the information 210 to the translator. The relays Z_2, H_1 and K_0 thereupon operate and, with their contacts, form two pyramids. Ground potential applied by contacts *f* and *x* in the storage now becomes effective at the output points 210 (area-code points) of the two pyramids. The zoning-code point 210 is connected by way of a jumper wire to zoning point 1, whose output rectifier energizes four zoning-result relays in the storage. The relays DK_4, Ze_5 and Zo_2 determine the zone. A jumper wire from the routing-code point 210 of the other contact pyramid leads to routing point 1, which is connected with the routing-result relay in the storage by way of the output rectifiers. In either case the f_1 contacts of the storage extend the circuit to the result relays. The last group of rectifiers serves for actuating further relays in the storage which perform various secondary functions (program). When the result relays operate, the storage cuts out automatically and releases the translator for use by other storages.

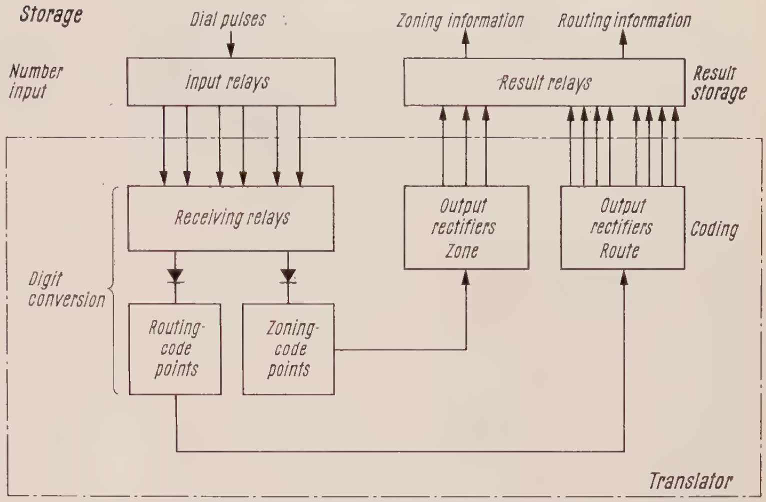


Fig. 2 Information processing in ESK translator

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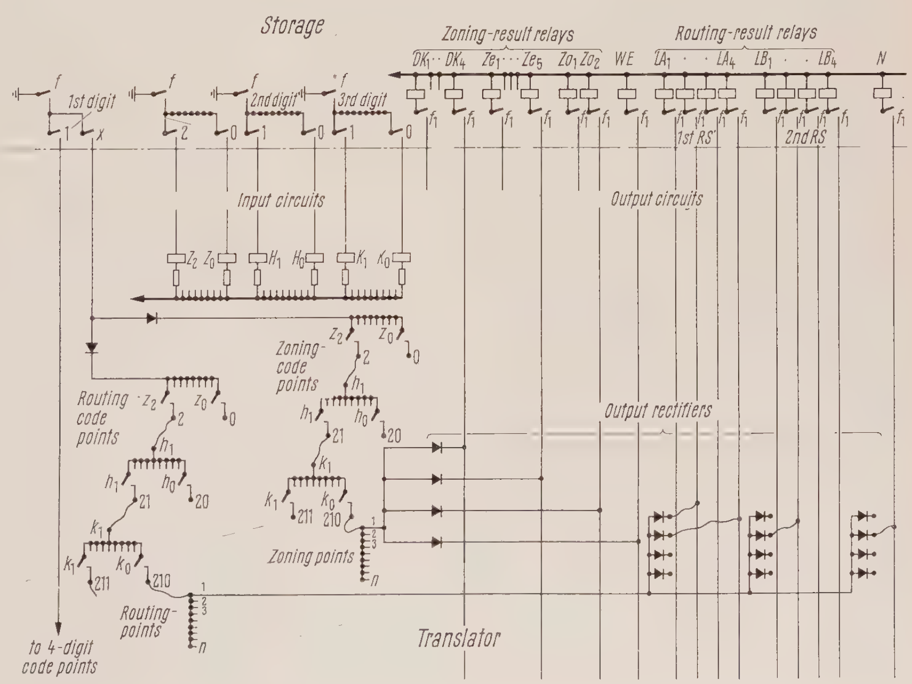


f, x Contacts of access relays
f_1 Sequential contacts of access relays
Z, H, K Digit-receiving relays
WE, N Secondary-function relays

Fig. 3 Operating principle of ESK translator. With, say, four *DK*, five *Ze* and two *Zo* relays, discrimination is possible among 40 zones; with four *LA* and four *LB* relays discrimination is possible among 15 routes in 1st and 2nd route selectors (*RS*) respectively

Siemens Data Processing System 2002

BY HORST SCHUBERT AND WOLFGANG WEISSER

The progressive application of electronic means in data processing and the development of better and faster electronic devices have combined to increase the performance of data processing systems (Figs. 1 and 2) to a level where they are capable of meeting extraordinary requirements.

A special display at the Siemens Stand at the Hanover Industries Fair showed the data processing system 2002 as the heart of a large system for integrated data processing. Its constructional design and potential applications will now be briefly described.

Constructional layout of system

The backbone of the data processing system 2002 (Fig. 3) is the central processor with its control and arithmetic unit. It controls and monitors the execution of instructions and the interoperation of the various independent equipment units connected. Ferrite core memories connected to the central processor as working storages have extraordinarily short access times and are so responsible for the high operating speed of the overall system. The backing storages such as magnetic tape units, high-capacity magnetic drum storages, and similar units are likewise linked to these central devices. All the units are interconnected with the central processor by way of buffer storages and, for the transfer of data between backing storages and buffer storages, operate completely independent of and in parallel with the central processor and other devices. Up to six control units, each serving for up to ten magnetic tape units, can be connected.

The central processor can be equipped with a control unit for printers and punched-card equipment at its input and output ends, so permitting the connection of five punched-card readers, five card punches, and five tabulating machines or high-speed printers.

The control unit for teleprinter and Siemens selex equipment serves for interconnecting the system with data transmission systems, or for interoperating with

Fig. 1
Data processing system 2002 at Munich computing center of the Telegraph and Signaling Division of Siemens & Halske

data gathering systems which may be installed at distant points, and enables up to 50 teleprinter input and output circuits operating at any of the conventional telegraph speeds to be connected in parallel. Siemens selex systems and Produktograph* systems can be connected up as well.

Through the addition of various supplementary features such as the floating-point attachment and magnetic drum backing storages the system can readily be adapted to all practical requirements.

Input and output options

There is an extraordinarily wide variety of data-gathering options of which only a few of the more important ones can be mentioned in the limited space here available.

The principal special devices for data gathering and distribution are Siemens Selex systems[1] and Produktograph systems[2].

Normal teleprinter equipment can likewise be used for data gathering and distribution. Messages can naturally be sent by pageprinter directly or over lines to the data processing system, and the same equipment can be used to receive and record messages from the data processing system. It is here of advantage that, where necessary, entire switching centers can be interposed.

If the places where data are to be picked up are located far distant from the data processing system, the information can be relayed directly to the system with the aid of transmitting equipment.

Conventional telegraph transmission equipment is here used, but in the future recourse will also be taken to high-speed transmission paths permitting telegraph speeds between 200 and 2400 bauds.

As the reliability of transmission is always a cardinal factor, special protection devices have been developed which, interposed in the lines, almost completely prevent the relaying of false signals to the central data processing system.

Typical applications

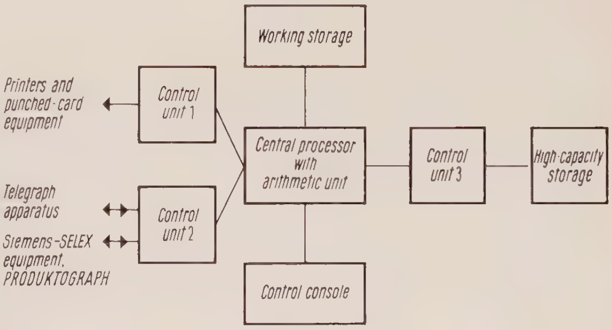
The Siemens data processing system 2002 is used for a wide variety of applications in industrial management and accounting. The principal applications of data processing in industrial management are various forms of production planning and scheduling. Applications in commercial management for industry and commerce, banks, insurance companies, and transport and communication organizations may be classified in three main

Fig. 2 Control console of data processing system 2002

groups: accounting (e.g. payroll accounting, material accounting, invoicing); bookkeeping (e.g. current account bookkeeping); planning.

Invoicing with center-punched cards

A typical application in commercial management is invoicing with center-punched cards, which is here described as an example.



Control unit 1: For controlling printers and punched-card equipment
Control unit 2: For controlling telegraph apparatus and Siemens selex equipment
Control unit 3: For controlling high-capacity storages

Fig. 3 Block schematic of data processing system 2002

* Trade-mark

1 Sehnert, F.: Einsatz des Siemens-Selex-Verfahrens in einer Arbeitsvorbereitung. Siemens-Zeitschrift 35 (1961) pp. 209 to 211

2 Fuchs, L.: Control of Production Runs by Produktograph Systems. Siemens Review XXVIII (1961) pp. 285 to 288

Commercial operations involve a considerable volume of invoicing work. In the case of integrated data processing, the basic invoice data are used in all subsequent processing operations. Specific data for the outgoing invoice book, for preparing statements of account, for statistics covering customers and the turnover of goods, for inventory accounts, for stockkeeping, and for placing follow-up orders with suppliers are derived from these basic data.

To allow a better comparison of conventional means of data processing with the new means of integrated data transmission and processing, we shall now describe the method of invoicing with punched cards.

Large commercial organizations normally dispose over a considerable number of warehouses or branches and prefer central invoicing for reasons of rationalization. In modern invoicing, customer addresses are drawn from a punched-card index for customers and information on the goods to be invoiced is drawn from a punched-card index for goods. The required quantities are assembled either from prepunched standard lot site cards or postpunched into the cards. The manually selected punched cards are now sent to the central invoicing system so that an invoice may be prepared. The invoice data for further processing are transferred to magnetic tape and sorted, selected, and the accumulated totals punched and printed.

Through the application of perforated tape equipment for the decentralized processing of incoming orders, the data required for invoicing are punched into tape. Such data consists of the number of the order and the customer's number per invoice, and the number of the article and quantity ordered per article. This information is relayed to the central invoicing system into which it is then moved. The system then extracts from its storages the customer's address appropriate to the customer's number and the article designation, price, discount, class, etc., appropriate to the article number. This is followed by invoicing and further processing in the manner already described. Customer numbers and article numbers can be safeguarded by the addition of check numbers to insure the detection of false punching. Simultaneously with the punching of the tape, a center-punched card can be prepared for each invoiced item containing the number of the order, the customer's number, the article number and the quantity ordered. Dispatching can be appreciably rationalized by sorting these cards in the sequence in which the articles are stored in the warehouse.

With data transmission over long distances it will be possible in future to invoice by means of a central data processing system in order to secure the already described advantages in connection with the further processing of invoice data. In spite of centralized invoicing, a printed invoice will immediately be available at the distant warehouse that can be packed in together with the goods. Data required for invoicing can, for instance, be relayed from the distant warehouse to the data processing system either over the telex network or over a point-to-point circuit. The central processor extracts from its storages the customer address, article designation and price, performs the necessary calculations, and returns a complete set of invoice data to the distant warehouse, where the invoice is now printed directly by a normal teleprinter or by Siemens selex equipment. If Siemens selex equipment is used, individual items of invoice data can be inserted, while at the same time delivery notes, stock issue slips, address labels, etc., are made out.

With this type of processing, stock control, i.e. control of the stock levels in each warehouse, can be performed centrally from the data processing system, while the decentrally printed invoice covers only the available items. On completion of the last invoice of the day, outgoing invoice books, stock requisition lists, stock inventory lists and similar information can be printed decentrally for each warehouse wherever the necessity arises. The same data is also available at the central data processing system, where it can be used for the central control of purchasing or other planning routines.

Invoicing of this type can operate just as well with decentralized warehouses within a closed factory compound as with decentralized warehouses located, say, in different parts of the country.

Booking seat reservations

The wide range of application of the Siemens data processing system 2002 is particularly well demonstrated by its advantageous use by commercial airlines and railroad companies for booking seat reservations. Order bookings may be communicated to the system by normal teleprinter equipment. Seat reservation systems of this type, which were hitherto classified as special systems, can now be assembled from the quantity-produced units of the data processing system 2002.

However, as the booking of seat reservations always involves the transmission of fixed quantities of data, booking agencies are frequently provided with special input sets which greatly facilitate this type of work. The information concerning the desired flight route is stored on an edge-punched card. Solely the variable data, such as the date, desired quantity of seats, class of service, and departure and destination airports are fed in by way of a simple 10-digit keysender and indicated to the operator and, if necessary, also to the customer by means of luminous digits and code lamps. Bookings can thus easily be checked before they are relayed – by pressing a start key – to the data processing system, which evaluates the booking requests according to the regulations for seat reservation and the available seats and sends back replies to the booking agency in a prescribed manner which can be freely chosen by the airline itself.

Besides requests for seats, inquiries and cancellations can also be relayed to the system, and the equipment can likewise be used to record the names of the passengers as is required by the majority of airlines, and to record and process special passenger requests.

The flexibility of the system makes it possible to meet the special requirements of airlines. During periods when business is slack, for instance, the system can be assigned to duties that may or may not be connected with the booking of seat reservations. It may be used, for instance, for gathering statistics covering completed flights and the payloads of aircraft, for accounting operations in connection with tickets or payrolls, or for preparing inventories of spare parts. A seat reservation system of this type can in this way be utilized with optimum economy.

Projection Welding — the most Rational Method of Resistance Welding

By Friedrich Czech

The projection welding process was developed about thirty years ago. At the beginning, the sheets were welded with normal spot welders and had only a few raised points or buttonlike projections. Five years later, the first projection welding machine was constructed but found only limited application in industry. It is only in recent years that the projection welding process has been applied on a larger scale as a result of the pressing need for rationalization. The use of projection welding machines affords the following advantages:

Increase in output
Reduction in bad welds
Lowering of production costs
Clean, dependable welds

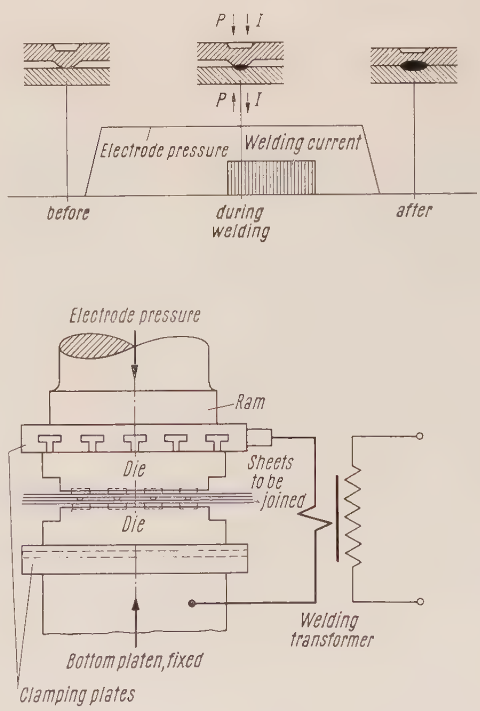
Projection welding is particularly suitable for the mass production of drawn or stamped articles. More recently, projection welders have been incorporated in modern production lines.

Projection welding process

In projection welding two or more parts are jointed at one or more points (Fig. 1). For the joining of metal sheets, for example, these points are fixed by making raised points or buttonlike projections. With mass articles the projections are made at the same time as the parts are drawn or stamped. With many parts the current path and the necessary localization of heat are determined by the shape of the parts, thus obviating the need for an additional change of shape.

As compared with spot welding, the advantages of projection welding are:

1. Many weld points can be made simultaneously with one electrode downstroke.
2. Satisfactory heat equalization during the welding of parts of widely differing size.
3. Limited variation in nugget strength in many applications and in particular with parts having closely spaced projections.
4. Long life and reduced maintenance of the electrodes.
5. Improved appearance of the workpieces.
6. Parts which cannot be welded by other methods may be joined by projection welding.
7. Projection welding lends itself to automation.



a Sequence of welding operations

b Simplified representation of the welding process

Fig. 1 Principles of projection welding

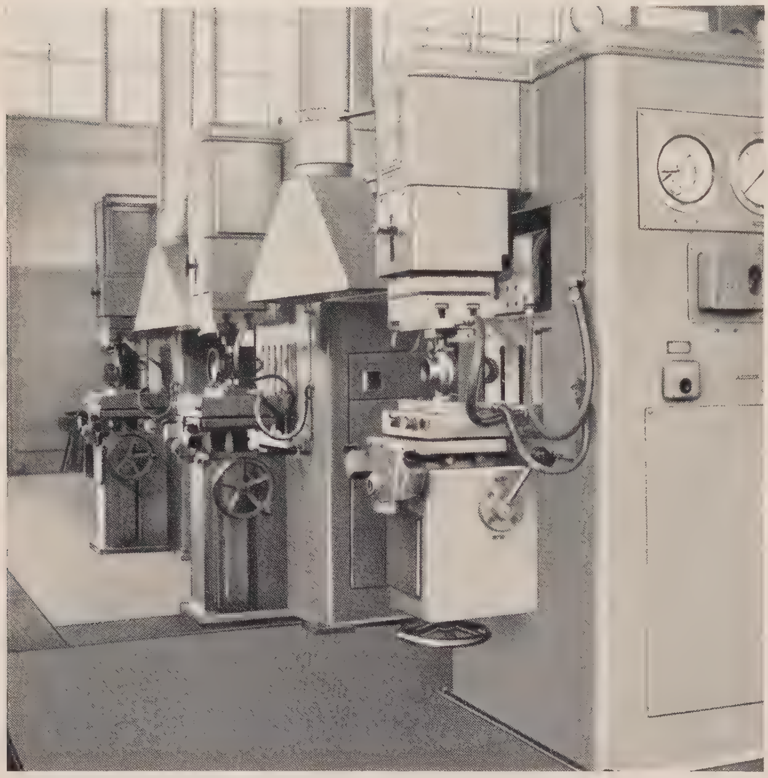


Fig. 2 Production line with 3 single-phase projection welders
The conveying equipment between the welders has been removed. In this production line three welding operations on spraying equipment are carried out one after the other

8. Dimensionally accurate welding to within ± 1/10 mm.
9. Reduced distortion since all welds are made simultaneously.

Projection welders and controls

As with the other resistance welding methods, the main factors in projection welding are the electrode pressure, welding current and welding time. In order to minimize the number of rejects in mass production, it must be ensured that these variables are maintained independent of the operator. Projection welders are therefore equipped with automatic welding timers to control the process after the machine has been started.

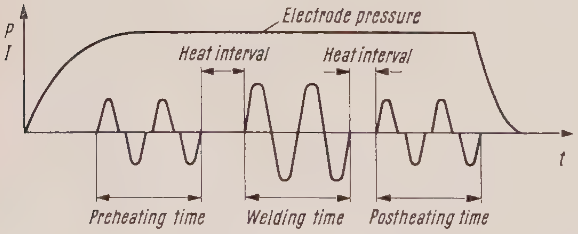


Fig. 3 Programme of a sequence timer: Preheating – Welding – Postheating

Mechanical construction

If several projections are to be welded simultaneously on one downstroke of the ram, the same electrode pressure must be applied to each projection (Fig. 1 *b*). For this reason, the projection welders must be designed and constructed for maximum robustness in order to obtain uniform distribution of the electrode pressure between all pojections even if the maximum electrode pressure is applied. The frame of the machine is in almost all instances of C-shape to facilitate feeding and operating the machine. For special applications portal-type projection welding machines are built. On small projection welders the necessary electrode pressure is produced by means of compressed-air drives, while the majority of medium and large-sized machines are equipped with oil-hydraulic drives. The hydraulically operated machine is more economical than the pneumatically operated type with its costly compressed-air consumption. The projection welding machines are built for electrode pressures of up to 6 tons. To obviate accidents the machines are provided with two-hand starting devices.

Single-phase a.c. machine

The model most commonly used is the single-phase a.c. projection welder (Fig. 2) which is built for ratings of up to 800 kVA. The secondary voltage required for welding depends upon the resistance of the welding points

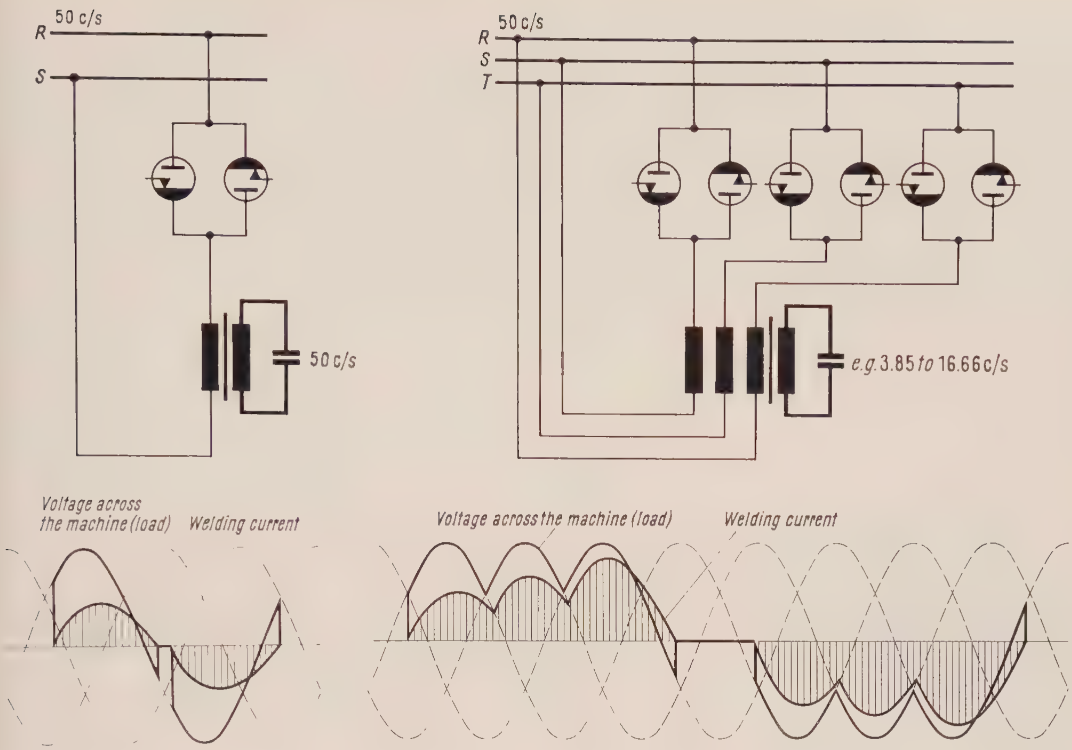


Fig. 4 Welder for single-phase (left) and three-phase (right) operation. Simplified circuit diagram, current and voltage waves

and transformer and on the reactance of the transformer and secondary circuit. The reactance drops depend on the secondary frequency of the welding current, the construction of the welding transformer, the arrangement of the secondary loop (window size), the shape and size of the welding stock and on its depth of insertion into the electrode arm projection.

Control of the single-phase machine

The weld time and the electrode pressure are automatically controlled by an ignitron contactor. The welding process is completed automatically by the ignition control after the starting signal has been initiated, i.e., after the simultaneous depressing of two pushbuttons (safety interlock), the valve "Ram down" is opened and starts the electrode motion. When the set electrode pressure is reached, the ignitron contactor switches on the welding current. The set welding time and electrode pressure programme is then completed. The ignitron control permits the most varied electrode pressure and welding time programmes to be set (with definite rise or fall in current). Fig. 3 shows the electrode pressure programme of a sequence timer. In the first step the surfaces to be welded are preheated with a low current; in the second step the welding current is applied and in the third step a low-energy pulse current is passed through the welded point to anneal the material in the fused metal zone. This last operation is called tempering.

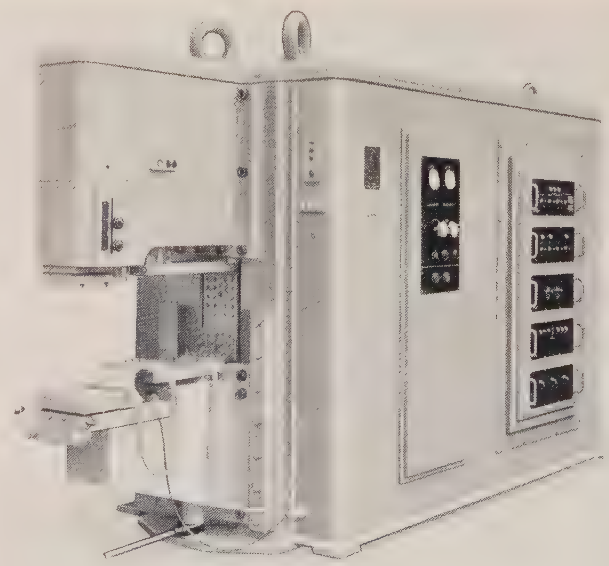


Fig. 5 Three-phase projection welding machine (6 ton electrode pressure, 120 kA maximum welding current) with current and electrode pressure programme control

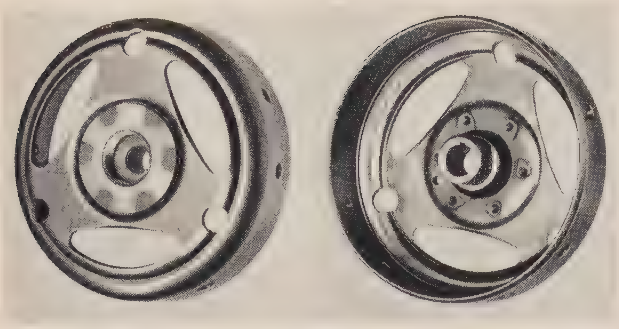


Fig. 6 Projection-welded starter armature

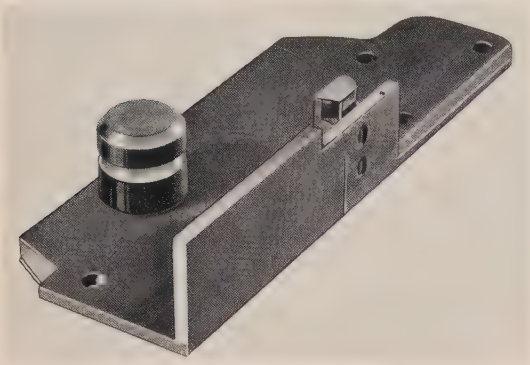


Fig. 7 Projection-welded window fitting. Bolt and stop are attached to a bracket by welding

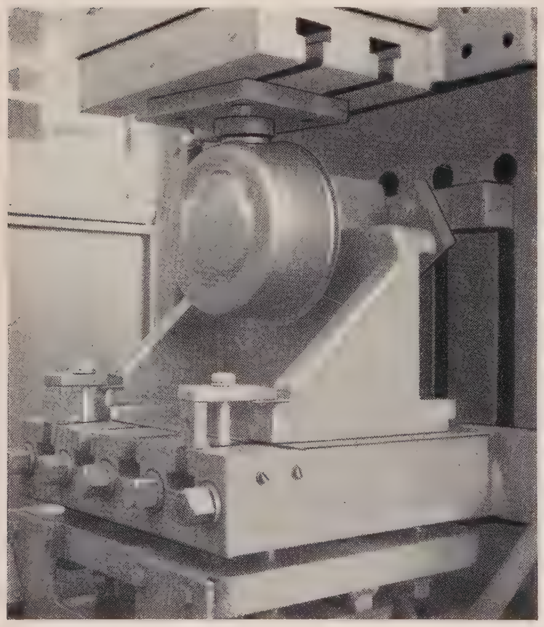


Fig. 8 Welding a fusite into a compressor casing

Projection welders for three-phase operation with reduced secondary frequency

If large bulky parts are welded at high currents, the single-phase projection welder absorbs a high apparent power. In low-capacity systems this results in heavy voltage drops and unbalanced loading of the phases. To improve conditions it is possible to use welders fitted with controls which evenly share the load between the three phases of the a.c. supply system and at the same time reduce the frequency. The reduction in frequency improves the power factor of the entire plant and reduces the wattless load. The circuit arrangement of a three-phase projection welder is shown at the top right-hand side of Fig. 4. The welding transformer has three separate primary windings and one secondary winding. All windings are arranged on the same iron core. Each primary winding is connected across two phases of the three-phase supply system via two ignitrons in back-to-back connection. The current and voltage waves are shown at the bottom right-hand side of Fig. 4. The ignitron control for the three-phase welder is known as a symmetrical timer by reason of the symmetrical division of the load between the three phases of the supply system. Fig. 5 shows a heavy-duty three-phase projection welding machine.

Examples of application

In the following, reference is made to a few examples of parts which had the projections impressed in the metal sheets or machined on the workpieces. An example is also given with which the current or heat concentration required for a sound weld is obtained by specially shaping the two parts to be welded together.

Fig. 6 shows a hub with six projections welded into a starter armature. The projections are impressed in the armature during drawing.

The projection welder also permits steel bolts to be welded at right angles onto metal sheets and fittings. For better current concentration the steel bolt is provided with a tapered end. Fig. 7 shows a window fitting to which a bolt and a stop have been attached by projection welding.

Lead-in pins (fusites) are now being welded gas-tight into casings on an ever increasing scale. The parts must be machined to very fine tolerances in order to ensure uniform distribution of current and electrode pressure over the entire surface of the projections.

This welding job involves very short weld times since the lead-in pins are sealed in glass. Depending on the size of the fusites, the following welding characteristics are required:

Welding current	70 to 90 kA
Welding time	6 to 10 cycles
Electrode pressure	3,300 to 5,500 lbs

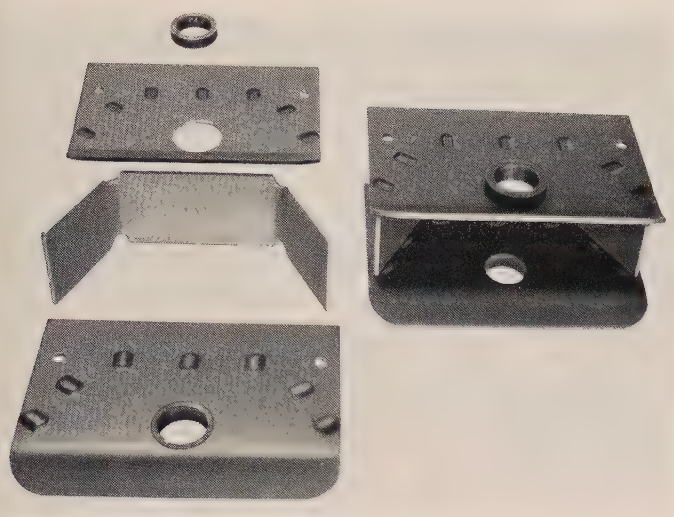


Fig. 9 Projection-welded coupling for a trailer

Fig. 8 shows such a lead-in being welded into a compressor casing. Compared with the former brazing method a saving of DM 0.70 per casing is made.

Fig. 9 shows the coupling of a trailer before and after welding. The coupling consists of five parts which are joined together by projection welding. First, the rings are welded into the upper and lower plate. For this purpose the rings are given a 45°-bevel. Following this, the upper plate, the web and the lower plate are welded together in one operation. Longitudinal projections are impressed in the upper and lower plate for efficient current concentration. The former wage costs with arc welding amounted to DM 0.70 per coupling. With projection welding they have been reduced to DM 0.075.

As these examples show, projection welding appreciably reduces labour costs which are decisive for the unit cost of the product.

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Teleperm Transducers

By Heinz Kronmüller

The transducer has the function to convert measured and controlled variables into standardized signals, this conversion either being strictly linear or taking place according to a given function, e.g. following a square-root or logarithmic law. As a result, set-point adjusters, indicators, and recorders for all quantities and ranges can be uniformly calibrated. Lag-free transmission of the measured variables to the control room is essential. Disturbance variables should not affect the measurement.

The various problems resulting from the great number of variables and ranges to be handled cannot be solved by means of a single instrument, but require a transducer system composed of a number of similar subassemblies. The many types of special-purpose controllers formerly used are replaced by an extensive program of the transducer manufacturing industry.

The electrical components of the Teleperm Transducer System

In most industrial plants, personnel is limited and the operators entrusted with maintenance mostly cannot take a special training course. For this reason, the individual subassemblies must be of high dependability requiring but a minimum of maintenance. They should be built up from a small number of similar components, so that even untrained persons may easily understand their operation.

Therefore, magnetic amplifiers [1] consisting exclusively of static parts of practically unlimited life (coils with soft-iron cores, silicon diodes serving as rectifiers, and capacitors) were chosen to work in conjunction with the electric Teleperm* Transducer System. These few, but reliable components of the magnetic amplifier are used throughout the whole Teleperm Transducer System for mechanical as well as for electrical input signals. For handling small d-c voltages, e.g. thermocouple voltages, only a static unit which is not subject to wear and tear and has a high zero stability will give satisfaction at the input of the amplifier. These requirements are fully met by the Magnetic Input Stage.

* Trade-mark

The transmission quantity of the TELEPERM Transducers

The high compatibility offered by the TELEPERM System is due to the fact that the output signals of all transducers, as well as of many other TELEPERM devices, such as the set-point adjuster, can be combined in a simple manner. This is only possible with d-c signals. The use of direct current as a transmission quantity offers the further advantage that the transmission lines are, to a high degree, unaffected by stray fields, and that forces can be produced (e.g. by means of plunger coils and magnets) which are strictly proportional to the intensity of the transmission quantity. These features govern the design of all instruments used for the transition from the TELEPERM to the TELEPNEU System, and are based on the balance of electric and pneumatic forces.

The need of transmitting the measured variables over distances of some kilometers (as frequently encountered in modern industrial plants) suggests the use of current signals of low intensity for a given output. On the other hand, the d-c signal should produce the greatest possible force in plunger coils, in order to avoid the necessity of providing extensive lever transmissions in the mechanical part of the transducer. Since the number of turns (i.e. the sectional area of the copper cores) that can be wound on a plunger coil is limited, current signals of an adequately high intensity are required. These considerations led to the standardized current range of 0 to 50 ma for the transmission quantity of the TELEPERM System. With flow transmission (mostly encountered in industrial plants), a line resistance of up to 400 ohms can be overcome, even if a recorder and a controller are connected in the circuit. Thus, with the usual conductor cross-section of .8 mm^2 (.0012 sq.in.) a distance of more than 5 kilometers (3.1 miles) can be bridged. A current intensity of 50 ma will produce a force of more than 100 grams (3.5 oz.) in a plunger coil of 150 ohms resistance. Therefore, in the electropneumatic devices of the combined TELEPERM-TELEPNEU* System [2], a simple lever transmission in the ratio of 1 to 15 is sufficient for effecting the balance between electric and pneumatic forces.

The three balancing methods of the TELEPERM Transducers

All TELEPERM Transducers operate on a balancing method. A compensation quantity produced by the transmission quantity is automatically balanced against the measured variable. Changes in the operation of the amplifier or the pick-up, both ensuring the automatic balancing action, will not impair the accuracy because the compensation quantity is continuously adjusted to the measured variable with but a negligibly small residual deviation. Fluctuations of the mains voltage, variations of the line resistance, or changes in temperature have therefore practically no effect upon the transmission signal. This signal, a load-independent direct current, is strictly proportional to the measured variable. For the same reason, the amplifier must not have any special

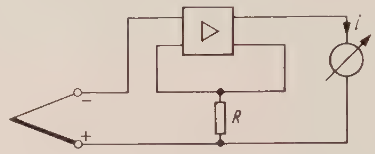

Fig. 1 Basic circuit diagram of the TELEPERM Temperature Transducer

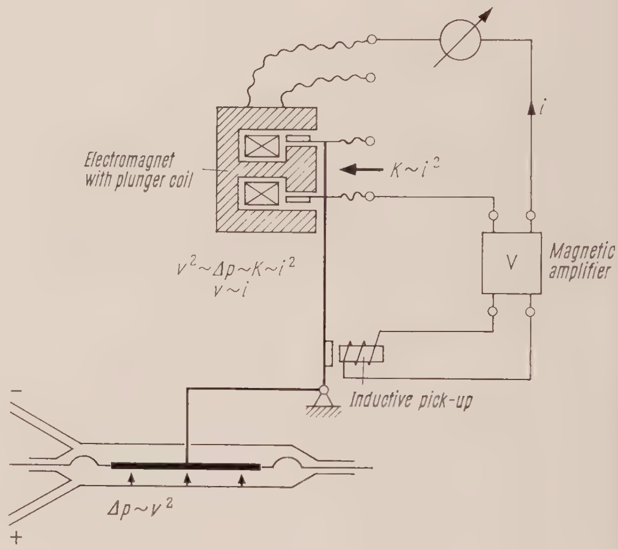

Fig. 2 Basic circuit diagram of the TELEPERM Flow Transducer (operating on the force-balance method)

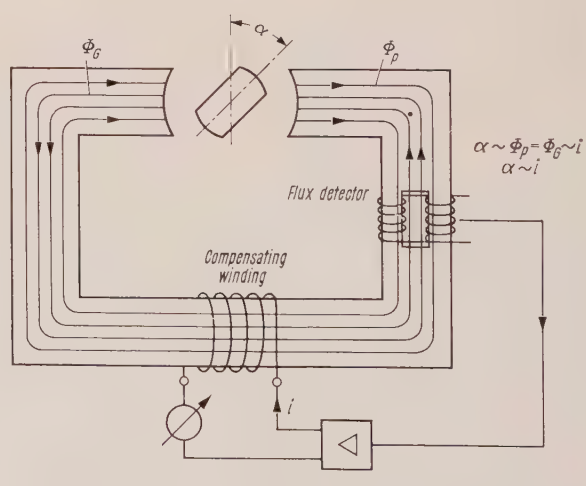

Fig. 3 Basic circuit diagram of the TELEPERM Pick-up

* Trade-mark

characteristic or stability. The balancing action effects that a current proportional to the measured variable is continuously flowing through the output of the transducer.

The Teleperm Transducers for electric input variables, such as thermocouple voltages, are provided with d-c amplifiers having a strong negative feedback coupling. The input voltage is balanced by a voltage produced through the amplifier output current across a fixed resistance. The small difference between the input voltage and the balancing voltage, amounting to about 0.3 per cent of the total range, is sufficient for full modulation of the amplifier (Fig. 1).

On the other hand, many of the Teleperm Transducers with mechanical input operate on the force-balance principle. The measured variable, e.g. a differential pressure, is transformed in the measuring cell into a force which is counteracted by the attractive force produced in a plunger coil by the output current of the amplifier. An inductive pick-up controls the zero position of the lever system. Any zero deviation causes the pick-up to vary the current flowing through the plunger coil in such a way that equilibrium between measuring force and balancing force is restored (Fig. 2).

If, besides flowing through the plunger coil, the current of the transducer also flows through the exciter coil of the plunger-coil magnet, the compensation force, and consequently also the transmission signal, become square-law functions of the measured variable. With flow transducers, the signal current will therefore be proportional to the rate of flow (Fig. 2).

The force-balance method only requires extremely small mechanical deflections. For this reason, wide ranges can be covered and continuously set, while on the other hand reliable dry diaphragm cells can be used even for small ranges instead of ring balances and bell-type meters otherwise employed for this purpose. The force-balance method, however, is of limited application for differential-pressure transducers in the case of high static pressures. This is due to the fact that the occurring high forces of some kg are difficult to transfer from the pressure chamber to the exterior without considerable errors. In such cases, and when the input signal comes in the form of a deflection, the Teleperm Pick-up is used [3]. The rotary movement of a small permanent magnet produces a magnetic flux, proportional to the deflection, in a soft-iron pole-shoe system. This flux is opposed to the flux generated by the output current in the compensating coil. Equilibrium of both fluxes is maintained by means of a flux detector operating in conjunction with an amplifier. This detector is controlled by the extremely small difference between the measuring flux and the compensating flux (Fig. 3).

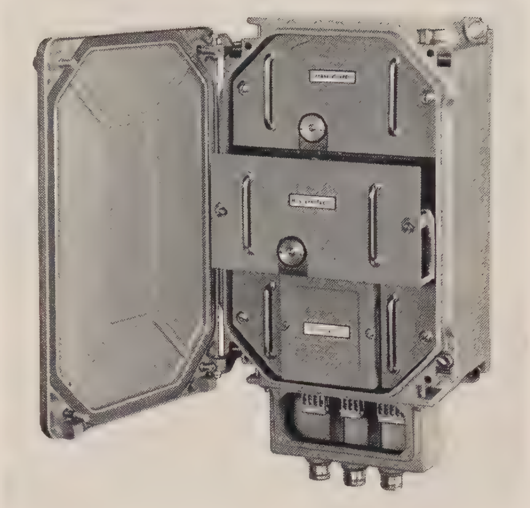

Fig. 4 Teleperm Temperature Transducer

Teleperm Transducers for electrical input

The necessary amplification is effected by two series-connected amplifier stages. The magnetic push-pull input stage is particularly suited for very small d-c voltage ranges of a few millivolts. In the case of the Teleperm Temperature Transducer (Fig.4), the amplifier, together with a plug-in power supply, is accommodated in a cast-metal housing. Another plug-in unit contains the measuring circuit and the voltage stabilizer for range suppression (if this facility is required).

The third plug-in unit comprises an isolating amplifier designed to physically separate the 50-ma output of the amplifier from the sensor. Thus, the latter and its leads are rendered intrinsically safe.

The sensor and its leads may have a joint resistance of up to 400 ohms. Owing to the use of voltage compensation, the transducer has an apparent input resistance of some kilohms. Variations of the line resistance or deterioration of the thermocouple will, therefore, hardly have any effect on the accuracy of measurement.

Teleperm Transducers operating on the force-balance method

By means of a plastic diaphragm, the measured variable (differential pressure) is converted into the measuring force which is transferred through a sealing bellows to the ambient air. The balancing of this force by the force of about 500 grams (17.6 oz.) exerted by the plunger coil is effected via two robust levers, and controlled by

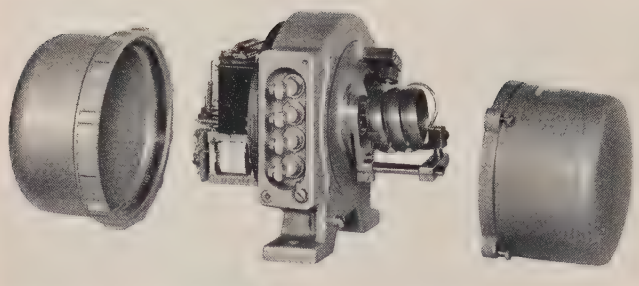

Fig. 5 TELEPERM Pressure Transducer

an inductive pick-up in conjunction with a magnetic amplifier. The instruments will withstand a static pressure equal to the full rated pressure. A continuous range adjustment in the ratio of 1 to 4 is possible. For pressure and differential-pressure ranges of 100 mm (4 in.) W. G. and higher, explosion-proof designs are available (featuring a compression-proof casing of the amplifier and increased safety for the mechanical part). Moreover, extremely corrosion-resisting diaphragms of TEFLON in stainless-steel chambers [4] can be furnished. The transmission quantity lying within the standardized range of 0 to 50 ma is connected to burdens of up to 500 ohms. The transducers for differential pressure are available for linear or square-root extracted output.

TELEPERM Transducers Operating on the Deflection Method

For converting deflections into a load-independent direct current, the TELEPERM Pick-up is exclusively used. A magnetic amplifier of special circuit arrangement is used as a detector for balancing the fluxes. A second magnetic amplifier stage takes charge of the further amplification of the signals at the output of the flux detector.

The TELEPERM Pick-up has given satisfactory results in quite a number of well-known measuring devices such as piston-type pressure gauges, all types of float manometers, Barton differential-pressure measuring cells with linear or square-root extraction lever systems, and mechanical level meters.

Moreover, a series of transducers for high pressures with the smallest range of 0 to .8 kg/cm^2 (Fig. 5) have been developed for being used in conjunction with the TELEPERM Pick-up. Helical Bourdon tubes of stainless steel are available, which directly produce the angle of rotation of 22.5° required for the TELEPERM Pick-up.

Scope of Application of the TELEPERM Transducers

TELEPERM Transducers have stood the test in all kinds of process industries, even under severe operating conditions.

A great many of transducers operating on the forcebalance principle are used in metallurgical plants for automatic process control. TELEPERM transducers have also proved useful for the electrical supervision as well as for the automatic control and operation of chemical processes. They have even gained importance in petroleum refineries which have hitherto been the almost exclusive domain of pneumatic control. A new field of application, the accounting and balancing of the power consumption in industrial plants, has been successfully opened.

TELEPERM Transducers designed for electrical input are used in conjunction with all types of thermocouples, resistance thermometers, and radiation pyrometers for all kinds of temperature measurements. Furthermore, they are often used in conjunction with special devices, such as gas analyzers and electronic load-cell equipment.

In steam power plants, the TELEPERM System has likewise asserted itself. Besides classical measuring instruments, such as float-type pressure gauges, nowadays also dry-type differential-pressure cells are used in conjunction with the TELEPERM Pick-up.

The individual units of the TELEPERM Transducer System constitute a complete line of dependable instruments meeting all requirements of the process industries. Electrical quantities down to 1 mv can be measured. Transducers operating on the force-balance method are designed for pressures and differential pressures ranging from 10 mm (.4 in.) to 6.4 m (21 ft.) W.G. and for static pressures of up to 25 kg/cm^2 (350 psi), while deflection-type TELEPERM transducers are available for pressures ranging from .8 to 400 kg/cm^2 (11 to 5,700 psi) and for differential pressures ranging from 1 m (3.3 ft.) to 32 m (105 ft.) W.G. at static pressures of up to 420 kg/cm^2 (6,000 psi).

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Electrical Equipment for Fertilizer Factories

By Otto Janisch and Karl Weber

In almost all countries of the world with a rapidly increasing population, mainly in Asia and Africa, fertilizer factories using locally available raw materials are being built in order to increase the yield of the soil [1]. The planning is either in the hands of local government agencies and private companies, or is entrusted to foreign specialized chemical-plant contractors and consulting engineers.

Technically, the production of nitrogenous fertilizers is mainly based on NH_3 synthesis, for which nitrogen and hydrogen are required. Nitrogen is extracted from the atmosphere by an air separation process, while hydrogen is obtained from coal in various forms, coke-oven gas, natural gas or from water by electrolysis, depending on the raw materials and energy available. Considerable amounts of energy in the form of electricity and steam are required for these processes (Table 1). Their production costs, therefore, have a decisive influence on the price of the final product and thus on the competitiveness of a specific process.

Example	Fertilizer, process	Consumption per ton[1] of final product	
		Electric power kWh	Steam tons/h
1	Fertilizers containing about 20 to 35% N; coke-gas base (excluding gas generation)	600	0.20
2	Same; natural-gas base (requiring a considerable amount of power for the O_2 compressors)	1,500	2.00
3	Same, containing approx. 45% N (urea); coal base	2,200	2.10
4	Same, containing about 20 to 35% N; electrolysis	3,000 and more	
5	Calcium cyanamide	3,000	

1 Metric values

Table 1 Examples of average energy requirements in the fertilizer industry

Power generation

In the case of processes requiring large quantities of steam (see examples 2 and 3 in Table 1), the factory-owned power station constitutes the most favourable solution, as it simultaneously produces both the required steam and cheap power by utilizing the high temperature drop in a back-pressure turboset. Since the power and steam requirements do not normally vary proportionally, the

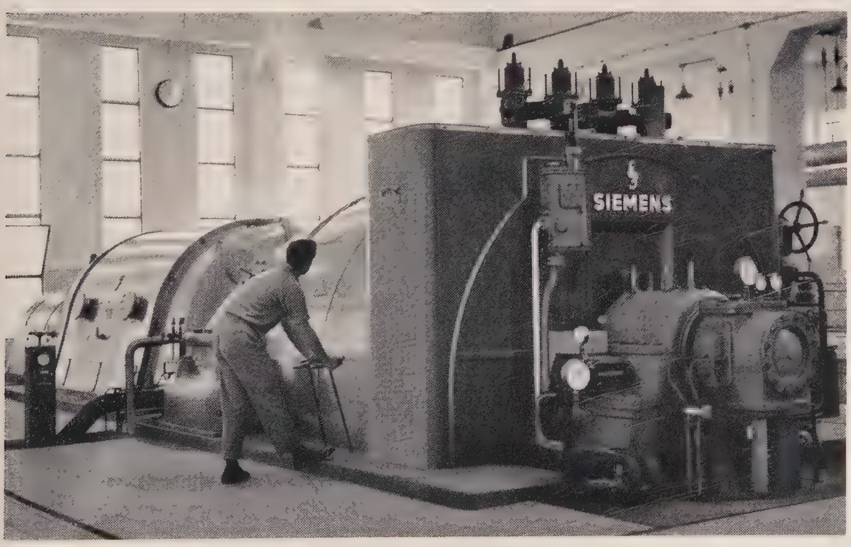
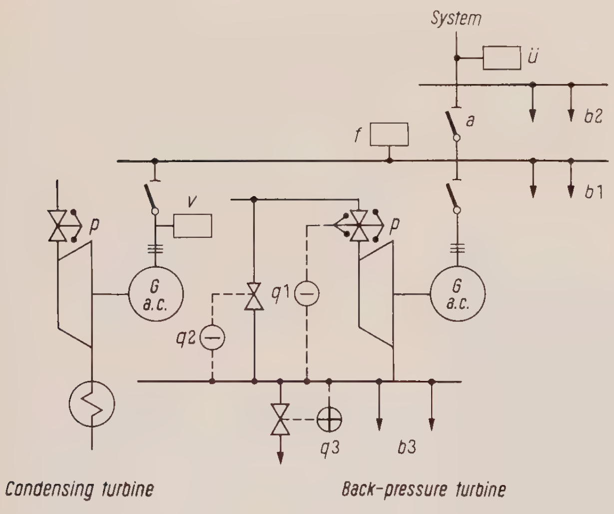


Fig. 1 Extraction-condensing turboset, 20 MW, 42.2 kg/cm² gauge (600 psig), 440 °C, in the fertilizer factory of Sté. Egyptienne d'Engrais et d'Industries Chimiques, Suez, Egypt

extra power needed is generally obtained either by connecting the factory to an outside system, by installing a secondary condensing turboset (Fig. 1) in addition to the primary back-pressure set, or by installing an extraction-condensing turboset instead of the back-pressure turboset. Where the back-pressure set is operated in parallel with an outside system, a great variety of regulating functions are involved. Normally, the turbine is controlled for constant back-pressure. The amount of electrical power generated then depends only on the steam requirements of the factory, and does not normally cover the power requirements of the factory. The extra power required is imported from an outside system. Should the supply from the latter fail, the turboset must be controlled for constant power instead of constant back-pressure. The change-over is effected automatically, the controlling element being a frequency-sensitive voltage relay. At the same time, the pressure in the steam system of the factory is maintained constant through a reducing station or a by-pass valve, brought into operation automatically.

Further control functions are involved if the unit costs of factory-generated power and the electricity price agreed upon with the power supply company imposes limitations on the import and export of electrical energy. Should the factory-generated power not cover the requirements, it will be possible to maintain an emergency service by disconnecting those loads which are not essential for production; these loads may, for instance, be supplied



a Bus coupler
*b*1 Essential electrical loads
*b*2 Non-essential electrical loads
*b*3 Steam-consuming equipment
ü Transfer controller
f Frequency relay or voltage-sensitive relay
p Speed controller (controlled by speed or back pressure)
*q*1 Pressure regulator
*q*2 Pressure reducing station
*q*3 Discharge station
v Constant load regulator

Fig. 2 Possible applications of control systems for economical steam and power generation

from a separate bus. Power generation can be optimized by using suitable speed and pressure governor combinations [2]. The various possibilities are illustrated in Fig. 2.

Fertilizer factories whose steam and raw-material requirements are covered by coke or steel plants obtain the necessary power through separate transformer substations.

Power distribution

A prerequisite for the technical and economical application of a selected production process and for a suitable power generating and distributing system is a careful physical layout of the entire plant. The large compressor drives for the gas and air separation and synthesis processes are normally centralized in halls and constitute the load centres proper. Grouped around them are smaller but numerous items of power-consuming equipment, such as electric motors, heating transformers, lighting systems and d.c.-operated control and supervision equipment. The factory-owned power station or main transformer substation should be so located that the distances over which the energy must be transmitted are kept at a minimum. Even the largest fertilizer factories normally cover areas smaller than 1 km^2 (0.39 sq. miles). The switchboards in the load centres are therefore supplied direct from the main bus of the power station or main transformer substation. The voltage mostly used is 6 kV, in accordance with the standard VDE preferred-voltage series; this makes for the most economical design of large motors with ratings from approximately 120 kW up to several thousand kW. Loads of less than 120 kW are supplied at 500 V or 380 V. High voltages in the lower range, e.g., 3.3 kV, necessarily involve the installation of a triple-voltage distribution system of, for instance, 11/3.3/0.4 kV; in the case of lower ratings up to about 50 MVA, this results in higher capital costs and distribution losses compared with the conditions obtaining with a dual-voltage system [3].

As far as the selection of circuit breakers, isolating switches, instrument transformers, etc., and the mechanical and thermal short-circuit strength are concerned, the design of the main switching station in the power station and main transformer substation is determined by the total power and impedance of the generators, transformers and large motors, as well as by the short-circuit MVA of the outside system. In the analysis, synchronous motors are dealt with in the same way as generators, whereas with induction motors only their share of the impulse short-circuit current need be determined, neglecting the tripping and sustained short-circuit currents. In order to reduce the capital costs, the h.v. sub-distribution boards in the factory and power station are built for short-circuit ratings of 100 or 200 MVA and are supplied via current-limiting reactors, where necessary. The size and number of the transformers feeding in

are determined by the short-circuit strength of the l.v. distribution boards and the connected load.

Switchgear

The metal-clad type of switchboards is preferred in all countries, especially overseas. This type is characterized by complete protection against accidental contact, good protection against dust, compactness and short erection times [4]. Open-type h.v. main switching stations are erected in rare cases only, e.g., where the larger space required is available and local conditions permit the use of this type of station.

The metal-clad h.v. and l.v. switchboards with flanged-on Clophen-filled[1] transformers form integral stations which can be installed direct in the load centres wherever desired, unless there are particularly severe conditions (presence of H_2, NH_3) requiring special protective measures against explosions; should this be the case, separate rooms which are not subject to explosion hazards and are suitably ventilated must be provided for the load-centre substations, the passages for the connecting cables carefully sealed against the danger zones. For the h.v. cubicle-type switchboard a drawout switchgear truck accommodating the circuit breaker and instrument transformers is used, so that the equipment is conveniently accessible. The switchgear units are subdivided into various compartments which confine the effects of fault arcs to small spaces. Pressure relief flaps prevent serious damage. The l.v. switchgear is provided in the form of metal-clad panels with unitized drawout sections which can be combined and arranged as desired to suit the particular requirements.

The location of the larger motors determines whether they can be connected direct to these main switchboards, which are otherwise used to supply sub-distribution centres controlling groups of motors.

Continuity of reliable power supply

Continuity of the power supply is secured primarily by installing stand-by generators and transformers which are always ready for service. In the event of a fault occurring, the essential loads are switched over to the healthy system sections, using automatic gear, if required, to achieve a high-speed change-over. The distribution switchboards are, therefore, provided with two incoming feeder units and selectively graded protective gear. Fig. 3 shows an example where a system fault is coped with while production is maintained. Each incoming feeder is rated for the full power demand and fitted with directional, instantaneous overcurrent relays. The total opening time of the breaker-relay combination is about 180 milliseconds. In the event of a short circuit occurring at point "*a*" of the feeder cable, for instance, the resulting voltage drop on the station bus is almost eliminated within 180 milliseconds through the selective isolation of cable 2, the remaining undervoltage disappearing entirely after a grading time of 1.5 seconds. The h.v. motors, including the 3,200-kW synchronous motor, as

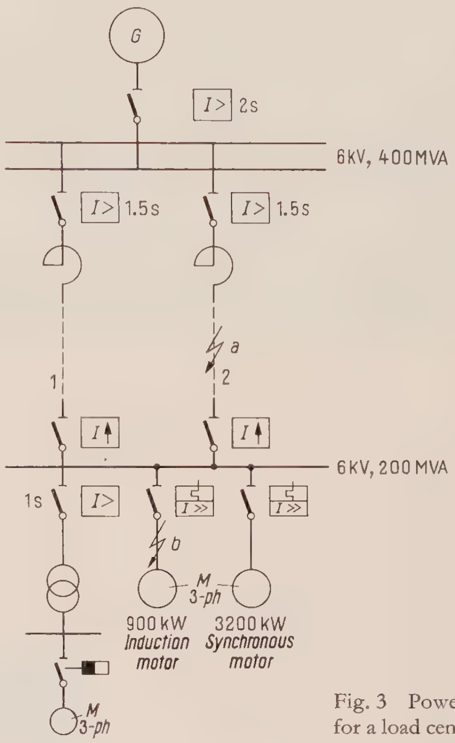


Fig. 3 Power supply system for a load centre

well as the essential l.v. motors which are connected via off-delayed contactors remain in operation. The synchronous motor will not be shut down even if, for instance, a short circuit occurs at point "*b*", since the instantaneous trip of the bimetal relay will likewise isolate the faulted circuit within a total opening time of 180 to 190 milliseconds.

Electric motors

In fertilizer factories, electric power is primarily required for conversion into mechanical energy – if one leaves out of account such loads as rectifiers for the electrolysis of water and calcium carbide furnaces which are not required for all production processes.

The power requirements for the various motors driving pumps, blowers, compressors, agitators, mills, conveyors and hoisting equipment vary between less than 1 kW and several thousand kW per unit. All the motors must be suitable for continuous duty and for the special conditions prevailing in chemical plants (high resistance to heat, moisture, corrosion and contamination) [5]; in addition to this, they must be designed for operation in explosive atmospheres.

1 "Clophen" is a trade-name for a synthetic non-inflammable liquid.

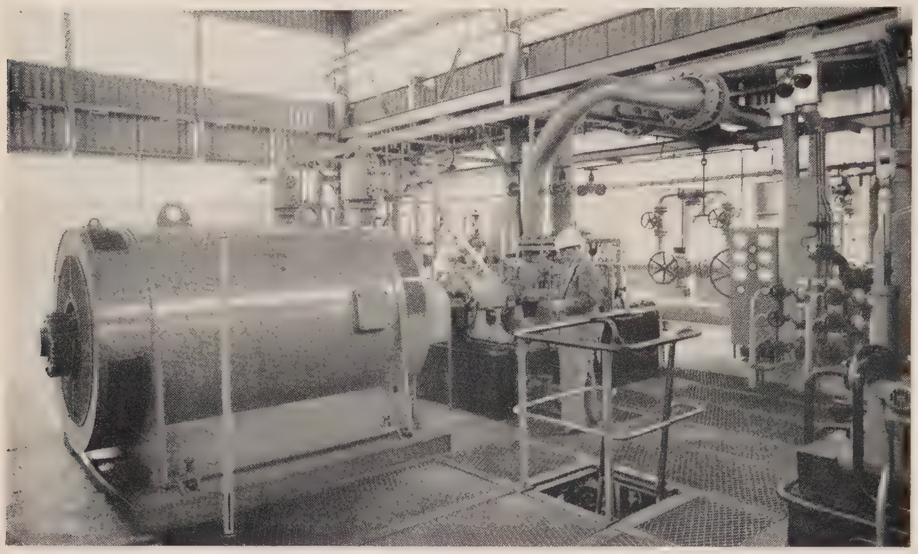


Fig. 4 Motor, 1,300 kW, 5 kV, 1,485 r.p.m., of "increased-safety" design for use in explosive atmospheres, installed in a chemical plant

Totally enclosed squirrel-cage motors with enclosure P 33 to DIN 40050 are particularly suited for use in fertilizer factories, as in the chemical industry in general. As far as protection against explosion is concerned, the "increased-safety" construction (Ex)e to the German VDE Specifications 0171 (Fig. 4) is normally used, unless particularly exacting conditions or the Standard Specifications of the country concerned require motors with flameproof enclosure (Ex)d or pressurized enclosure (Ex) f.

For the less frequent applications requiring variable-speed drives, three-phase commutator motors or magnetic-amplifier-controlled d.c. motors with pressurized enclosure are employed.

The large compressors and pumps requiring several thousand kW are driven by synchronous or induction motors which are of the low-speed or high-speed type, depending on the type of compressor [6]. These motors have a closed-circuit cooling system, the coolers being installed either inside the motor frame or in the motor foundation. The motors are of the "increased-safety" design or are provided with a pressurized enclosure to make them suitable for use in explosive atmospheres (Fig. 5).

In selecting the type of motor, consideration should be given to the effects on the supply system during starting and operation. The starting currents of induction and synchronous motors of the same ratings are almost equal, whereas power factor values and the characteristics obtained in response to voltage fluctuations differ. The induction motor draws reactive power from the system, whereas the synchron-

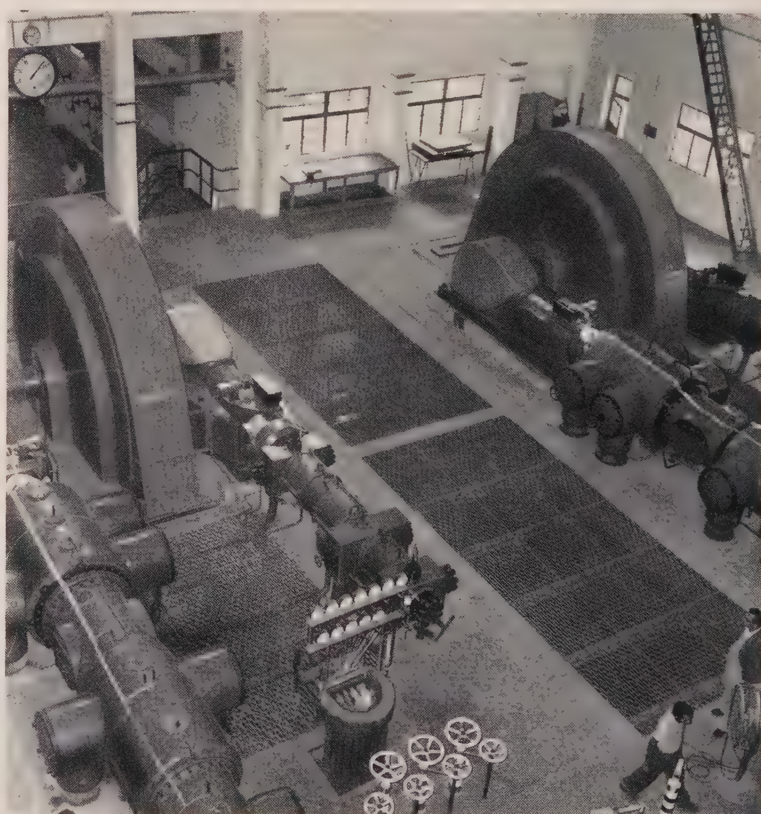


Fig. 5 Synchronous compressor motors, 2,000 kW, 6.6 kV, 150 r.p.m., of "increased-safety" design, in the fertilizer factory of New Central Jute Mills Co., Ltd., Varanasi (India)

ous motor can supply reactive power to the system, depending on the type of duty and the excitation conditions.

When voltage variations occur in the system, the induction and synchronous motors behave differently, depending on whether a short-time voltage drop to about $\frac{1}{3}$ of the rated value or a sustained voltage reduction to about 60 to 65% of the rated voltage is involved. The different behaviour results from the fact that the torque of the induction motor changes in proportion to the square of the voltage, whereas that of the synchronous motor decreases as a linear function of the voltage; the induction motor, moreover, is capable of accelerating again to full speed after a short-time drop in speed. The synchronous motor can only operate at synchronous speed and will fall out of step when slip occurs at rated load (Table 2).

Type of motor	Voltage drops to about 60 to 65 % of rated value for 1 to 3 secs.	Short-time voltage drops to 33 % of rated value for about 0.5 sec.
Synchronous motor	Continues to operate with constant excitation	Stalls
Induction motor	Stalls	Continues to operate

Table 2 Performance of three-phase induction and synchronous motors during voltage drops in the system while operating at rated load

The conditions obtaining with respect to the consumption of reactive power in the case of synchronous motors being used instead of induction motors for large plants are illustrated by the energy balance (Fig. 6) shown for a fertilizer factory with an aggregate rating of 23 MW. If induction motors are used for all drives, an apparent power of $N_S' = 26.8$ MVA (vector AB') results at an overall power factor of $\cos\varphi' = 0.86$. If, however, synchronous motors are selected in the air and gas separation section for two drives of 1,450 kW each and for one 3,000-kW drive in the synthesis section operating at a leading power factor of 0.9 (vectors CD and EF instead of CD' and $E'F'$), the MVA rating is reduced to $N_S = 24.1$ MVA (vector AB), while the power factor is improved to 0.95. The reactive power drawn from the system is reduced from 13.8 to 7.25 MVAr. This should be taken into account also in the case of factory extensions [7].

The advantage of the squirrel-cage induction motor is that its construction is simpler and that it does not require any auxiliary gear for starting and running. Synchronous motors, on the other hand, require automatic starting gear and an exciter set or a rectifier for the excitation circuit, which require additional space and a certain amount of maintenance. The advantages and disadvantages of the two motor types should be evaluated for each particular project and the motors selected accordingly [8].

The starting currents of large motors, which are of the order of 3.5 to 5.5 times the rated current, cause short-time voltage drops in the system. The effects of these starting currents on the remaining equipment connected to the same bus should be investigated. The results of these investigations will determine whether the starting currents should be reduced by the use of appropriate starting methods, e.g., reduced-voltage starting with starting transformer, reactance starting or – in some cases – part-winding starting. If several identical drives are involved, one common starting transformer may be used for the reduced-voltage starting of several motors.

In the case of reciprocating compressors, the torque to be delivered by the motor varies in the course of one rotation. This results in current fluctuations causing voltage variation in the supply system at a frequency which corresponds to the motor speed. The voltage variations, the magnitude of which is also determined by the capacity of the supply system, may have a detrimental effect on the remaining power-consuming equipment and may, for instance, cause the light to flicker. The voltage variations can, however, be satisfactorily corrected by increasing the flywheel effect of the motors and/or by appropriately setting the cranks of two- and multiple-crank compressors. The tangential-effort and torque curve of the compressor manufacturer should be available for investigating these effects on the supply system.

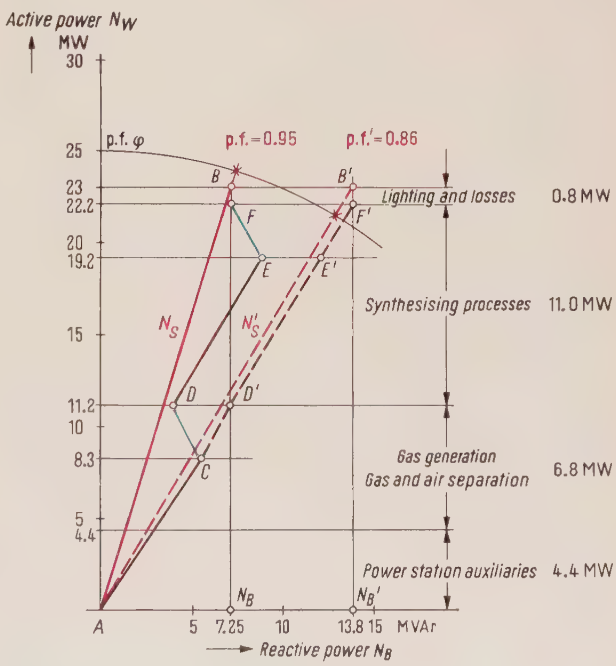


Fig. 6 Energy balance

Standard specifications	Climatic conditions	Miscellaneous
VDE IEC, B.S. ASA, NEC NEMA Also to be considered: Protection against explosion hazards is required in many locations (H_2, NH_3)	Max. air temperature Relative atmospheric humidity in % Rainy season, degree of condensation Constituents of the air, e.g., brine, sulphur compounds, sand Mold fungi Damage by termites, ants, lizards, rats, snakes Exposure to solar radiation ↓ Tropical finish	Packing Transport and storage conditions Customs clearance

Table 3 Specifications and conditions applicable to the erection of electrical plants for fertilizer factories abroad

General

The cable runs inside and outside the building should be planned in good time and co-ordinated with the planning of the building and the routing of the pipelines, roads, drainage system, etc. Clear marking of the cables is indispensable. Special attention should be paid to suitable earthing. For l.v. systems, the protective-earth conductor system affords the advantage of undisturbed operation if a single-phase-to-earth fault occurs. The earth fault can be located and remedied whenever convenient by throwing a special knife switch to establish a temporary connection between neutral and earth.

The standard specifications, regulations and conditions listed in Table 3 must be complied with when designing, delivering and erecting electrical plant for fertilizer factories abroad.

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Transmitter Technique for Shore Radio Stations

By Werner Gawlick

Radiocommunication between ships at sea and mainland communications networks relies on the existence of shore transmitting and receiving stations adapted to the particular requirements of marine radio services. Siemens & Halske have participated in many places – and after 1945 under their own name – in the establishment and expansion of shore radio stations in Germany and other countries.

Shore radio stations have long been of invaluable assistance to ocean-going vessels, enabling the captains of ships on the high seas to receive instructions from their respective shipping companies regarding, say, the re-routing of cargos. Passengers on large passenger vessels also make frequent use of the opportunity of sending cables or making long-distance telephone calls to business associates on land during the voyage. Telephone calls are here conducted in exactly the same way as long-distance calls on land.

Services concerned with safeguarding human life on vessels at sea operate on a priority basis. These include the sea rescue service for ships in distress, the medical radio service enabling doctors at sea to consult specialists on land on the treatment of passengers or crew members in their care, the safety radio service for reporting on the location of icebergs, wrecks and mines, the meteorological service which transmits regular bulletins at fixed times, and the time signal service which is of great value in calculating the position of a ship. For these services alone it is necessary for shore radio stations to be manned day and night so that instant measures can be taken to organize aid whenever a distress call is picked up.

Modern transmitting and receiving equipment differs vastly from that of the first longwave receiving stations, which used to operate with unstable coherers. While ranges from 1000 to 2000 km were earlier considered adequate, large shore radio stations must today be in a position to contact ships sailing all the seven seas, whether they be whalers in the Antarctic or captains wishing to send messages to their shore bases before

Fig. 1 Antenna system of Norddeich shore radio station

reaching the open sea or entering a harbor. This means that both long-haul and short-haul calls have to be established. The transmitting and receiving equipment for the various wavebands has to be dimensioned according to the required ranges of transmission. Owing to its long range, the shortwave band is reserved for long-haul communication only. Long-haul communication is assigned the range from about 80 to 188 m (1.6 to 3.75 mc), where propagation is particularly favorable for long distances and therefore ideal for both day and night transmission. The power outputs of the transmitters are naturally adapted to these conditions.

The simultaneous operation of the various services, the introduction of new ones, and the steady growth of merchant fleets results in a heavy traffic density. Statistics for 1956 recorded by a German shore radio station show that it handled some 290,000 telegrams and 43,000 long-distance calls, whereas the statistics for 20 years earlier (1936) record only about 110,000 telegrams and some 1000 long-distance calls. In order to cope with the increasing requirements and the many different services it is necessary for modern radio equipment to meet high standards with respect to readiness for service and operating reliability. Radio operators at sea or on land have to be able to establish reliable radio contact at any time with little or no delay. The responsible authorities of all countries for this reason make every effort to adapt their stations to the latest state of the technique and to keep pace with the growing traffic density.

Shore radio stations are usually situated at a suitable distance away from large cities, the antennas used for the various services and wavebands requiring a considerable amount of ground on account of their large size. Another very important factor in the choice of location is that the electrical noise fields encountered in cities would prevent proper reception at nearby receiving stations. Receiving stations should be located several miles away from transmitting stations so that the receivers cannot be "plugged up" by the transmitters of their own station in cases where transmitters and receivers have to operate on adjacent frequencies. Radio operation is usually carried on from the receiving station. There the personnel in charge of the receivers search for call signals in the frequency bands assigned to them for observation; they order one or more transmitters from their associated transmitting station. The transmitter operators thereupon switch on the ordered transmitters, tune in the desired frequency, and select the desired class-of-emission.

The largest of Germany's numerous shore radio stations is Norddeich, whose name and call signal have for over 50 years been familiar to ships in all parts of the world. This station is located near the border between Germany and The Netherlands, and vacationers visiting Norderney or Juist are struck as they leave the mainland by the sight of the high antennas towering upwards behind the dike (Fig. 1).

Fig. 2 shows a number of the transmitters of this shore radio station that were supplied by Siemens & Halske about 5 to 7 years after the end of the World War II. The transmitters have power outputs of 10 kw and 20 kw. Each transmitter consists of one or two prestage bays, a power stage bay, a cable matching unit and a power supply unit. The power stage of the 20-kw transmitter

operates in pushpull and is equipped with water-cooled triodes. The cable matching unit matches the power stage into the antenna feeder cable. In the event of mismatch due to ice deposits on the antennas, ground haze, or flashovers in the protective spark gap due to atmospheric or manmade interference, the transmitter is automatically shut down by a detuning protection device. The detuning components of the power stage and the cable matching unit consist of cooled wiper variometers and capacitors that are switched in steps. The d-c voltages of 250 v, 800 v, 2.5 kv and 6.5 kv (grid bias, screen grid voltage, anode voltage) required in operating the transmitter are still generated with grid-controlled tube rectifiers. These oxide-coated cathode rectifiers operate for the most part in a threephase bridge circuit and sometimes also in a threephase Y-connection or, for generating half the d-c voltage, in a combination of both using the same tubes and the same main transformer with its neutral point brought out. Each rectifier has a smoothing network which reduces the ripple content of the d-c voltage to its admissible value.

Such transmitters have to be switched on manually and tuned by trained technicians. Coarse tuning is performed according to prepared tables and fine tuning according to instruments in the top panel of the transmitter. Large stations therefore require many personnel in order to insure that the diverse operating requirements (simultaneous operation of several services, fast frequency-changing, rapid readiness for service) will be met. As it is becoming increasingly difficult to find a sufficient number of trained personnel, all countries are unanimous in demanding that the operation of stations be simplified by the widespread use of automation for switching on, switching over and tuning.

The development of transmitting and receiving equipment of this type prompted the creation of new components and the improvement, miniaturization and adaptation of existing components to the new conditions. The use of the dry-disk rectifier in the power supply units of transmitters, for instance, reduced space requirements considerably. The dry-disk rectifier also endowed the power supply unit with a practically unlimited service life, freedom from maintenance, and consequently great operating reliability and instant readiness for service. By comparison, the hitherto conventional rectifiers with oxide-coated cathode tubes require a warmup time and have a limited service life.

Transmitter design is closely linked with progress in tube technology. New tube designs have smaller dimensions and therefore permit applications at higher frequencies. Whereas high power outputs earlier demanded the use of triodes, whose small amplification factor made it necessary for a great many r-f amplifier stages to be connected in cascade, the introduction of new high-power tetrodes with large amplification factors has resulted in a marked reduction in the number of stages. This likewise means a reduction in the number of r-f tuned circuits and associated drive units. All these features make to reduce the overall dimensions of a transmitter and increase its operating reliability while securing faster readiness for service at the same time. The reduced number of tuning operations, for instance, is particularly advantageous if the frequency has to be

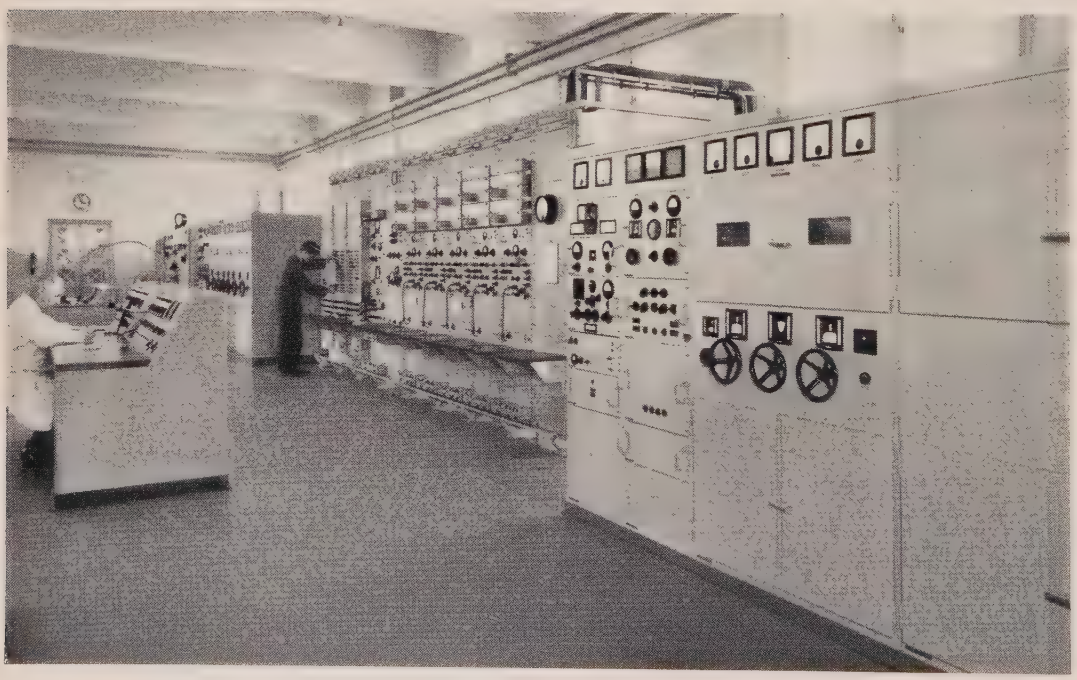
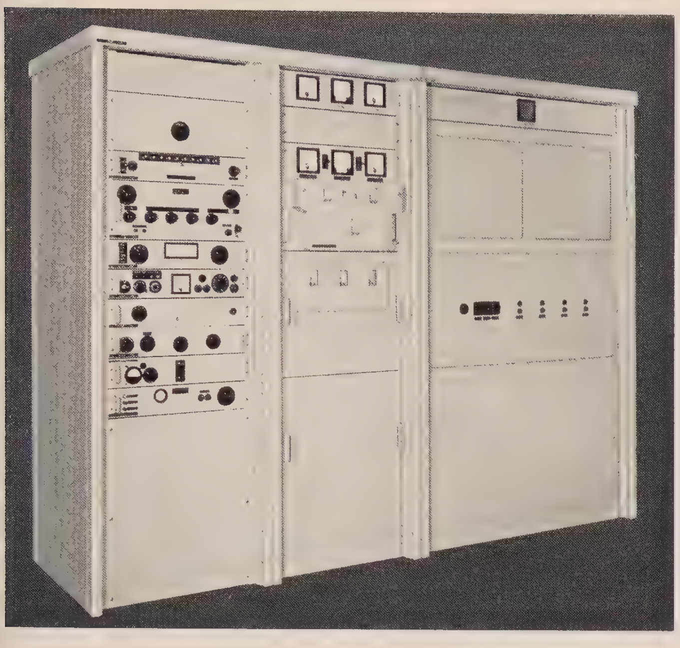


Fig. 2
Norddeich shore radio station
Front to back: a 10-kw short-wave transmitter, transmitter input bays, 20-kw transmitter for approx. 80 to 188 m band; left: control console



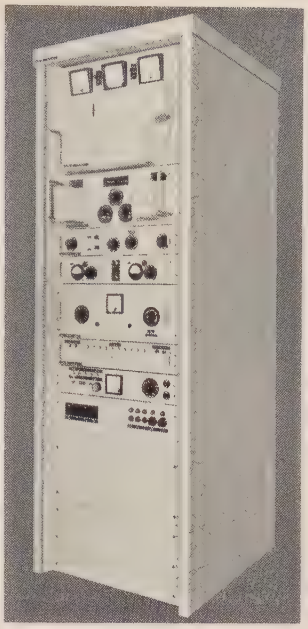


Fig. 3 (left)
10-kw shortwave transmitter, remote controlled

Fig. 4 (right)
1-kw shortwave transmitter, remote controlled

Both are transmitters with presetting facilities for any ten pushbutton-selected frequencies and all conventional classes of emission

changed several times a day in order to take account of the different conditions of propagation in the 80 to 188 m band and the shortwave band. A further step towards simplifying operation was the use of controllable electrical drives for the switching and tuning facilities. Transmitters of this type were already supplied to various shore radio stations as early as in 1958.

In these models (Fig. 3, 4) the tuning units are driven by motors, which are controlled by way of appropriate information storage mechanisms. The direct coupling of the tuning unit with its motor drive obviates the need for the conventional linkage, sprocket chains, or similar details. To satisfy the requirement for fast frequency-changing, the transmitters are equipped for pushbutton selection of any of ten preset frequencies. The control mechanisms are accordingly provided with ten variable contact cams which can be set to any position and permit the selection of any frequency within the frequency range from 1.5 to 30 mc. The actuation of an appropriate frequency button for changing the frequency causes a contact to make in the frequency selector unit embodied in the transmitter, following which all the tuning elements set to the selected position. An unambiguous return indication releases the transmitter for operation. As all tuning elements operate simultaneously, retuning times are short. For manual tuning, the pushbutton selector is disabled by means of a switch in the control console of the transmitter. A separate control console for remote control of the transmitter from a distant point such as the receiving station is used to transmit the following control signals: on/off, class-of-emission selection, selection of any of ten preset frequencies, return indication. This console is enabled or disabled by actuating a switch at the transmitter. Experience has already shown the use of these semi-automatic transmitters to lighten the work load of station personnel appreciably.

However, as this semi-automatic technique does not satisfy all requirements with respect to the simplification of operation, the Siemens organization began the development and production of full-automatic transmitters. Transmitting amplifier stages not designed for broadband operation here tune themselves automatically and continuously to the frequency injected by the high-stability oscillator stage. The automatic tuning control feature and the drive motors of the tuning units operate without moving contacts. Moving contacts are similarly avoided in the r-f circuits. The program of setting operations for, say, determining the injected frequency, tuning to resonance, and adjusting coupling and gain is controlled by an automatic unit which likewise operates with contactless components (Simatic* components). On/off switching of the transmitter, selection of class-of-emission, and the selection of any frequency in the range from 1.5 to 30 mc are likewise automatically controlled in the transmitter prestages. It is in this way possible for a single operator at the transmitting station to control several transmitters from a single console. Control signals for transmitter adjustments that recur again and again for certain services can be stored in electronically controlled programs and relayed to any transmitter from a central console. The program can be erased at any time and new control signals stored according to operational

* Trade-mark

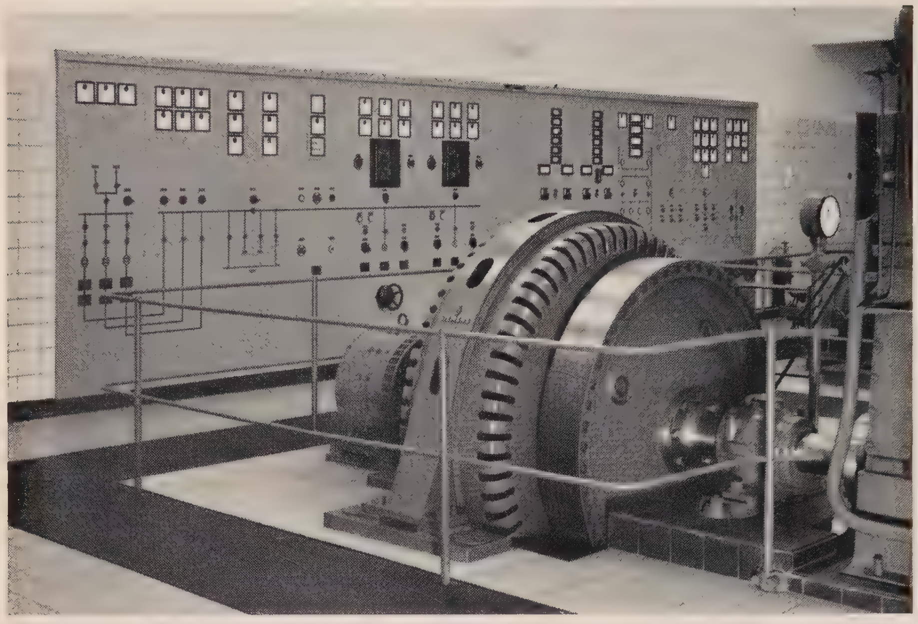


Fig. 5 Section of power supply equipment at Norddeich shore radio station

requirements. A return indication device at the control console indicates all control signals that take effect. The state of operation of the controlled transmitter can in this way be checked at any time. This technique enables the transmitters to be controlled at option or according to a program from a far distant point without new transmission systems having to be provided. Thus the duties of station personnel are restricted to the small amount of preventive maintenance required to keep the equipment in proper working order.

The antenna selecting switch is a valuable supplementary unit for shore radio stations. A great many antennas such as omnidirectional antennas or directional antennas of relatively narrow bandwidth are provided for the various services and frequency ranges. As a change of frequency or direction is very often necessary, the transmitter outputs are not permanently connected to an antenna but by way of an antenna selecting switch so that each transmitter can be switched to whichever antenna is temporarily required. This solution secures the necessary flexibility. The antenna selecting switch is frequently designed as a crossbar patching panel for coaxial lines. Reflection-free transition from the horizontal to the vertical r-f bus is accomplished by means of a plug-in unit. In modern systems the antenna selecting switch is equipped with controllable contactless electrical drives so that in the case of full-automatic transmitters it is also possible to include antenna selection information in the transmitter program. These automatic antenna selecting switches are thus operated from the control console of the transmitting station or from that of the distant point at the same time as the transmitter is set.

In shore and marine radio operation the only classes-of-emission used at present are A1 (c-w telegraphy), A2 (modulated telegraphy) for special services only, and A3 (DSB telephony). Whereas international long-haul communication would be inconceivable without the teleprinter and high-speed morse apparatuses operating with perforated tape, no headway has thus far been made in the mechanization of shore-to-ship and ship-to-shore communication, and messages are still transmitted manually and received aurally as in the beginning.

As we know from statistics, the number of long-distance telephone calls handled by shore radio stations is increasing annually. Since only a small number of shortwave telephone channels are available and delays in the handling of calls – particularly in the case of large passenger ships – are consequently growing longer, it is probable that it will be necessary in the near future to introduce the class-of-emission A3a (SSB telephony with reduced carrier). This would reduce delays by almost doubling the number of available channels.

The power required for the operation of shore radio stations is usually drawn from rural power distribution networks. In the event of a breakdown developing in these networks, those radio services upon which the safety of human life at sea depends must positively be maintained. For this reason the minimum complement of equipment of all stations includes highly reliable emergency generator sets which automatically start up or can be started manually in the event of any mains outage (Fig. 5).

NEW EQUIPMENT

Railroad Line Capacity Increased by Automatic Blocks

By Josef Ganseforth

The Gießen–Friedberg line represents an important railroad link between the northern and southern areas of West Germany. Trains from the north-west pass through Siegen and from the north-east through Kassel along the Gießen–Friedberg line to Hanau and Aschaffenburg in the south-east or to Frankfort in the south-west. Trains from the south likewise travel along the Friedberg–Gießen line to the north-west and north-east (see map).

Four railroad stations and two intermediate stops lie between the main junctions of Gießen and Friedberg. Hitherto, train traffic at the stations of Großen-Linden, Lang-Göns, Butzbach and Bad Nauheim was controlled from ten mechanical signal cabins. The line sections between the stations and intermediate stops, some of which were more than 6 km in length, were subdivided by four mechanical blocks and safeguarded by a manual a-c block. The length of the line sections and the time required to operate the mechanical signals determine the capacity of the line. As an increase in this capacity was no longer possible with the existing signal installations and the manual a-c block mentioned, the line was equipped with modern signaling facilities supplied and installed by Siemens & Halske.

In the first reconstruction stage the ten mechanical signal cabins at the stations were replaced by four cabins with all-relay interlockings. The latter are simple to operate, only a few pushbuttons having to be actuated to initiate each function. All the switches and signals of a station are now no longer set from several signal cabins but from a single cabin. The ease with which the pushbutton-controlled all-relay interlockings can be operated, and the centralized control and supervision of all the signal installations of a station, considerably reduce the time taken to establish and release routes, thereby securing smoother operation and enabling trains to pass through stations faster.

Survey plan of Gießen–Friedberg line

In the second reconstruction stage the existing mechanical line block was replaced by an automatic block. In the case of the old manual a-c block the operator had to watch for the end of the train, set his block signal to STOP, and lock it. The locking of the signal released the last block signal, which could then be reset for the next train. The many manual operations involved in the use of this type of line block consumed a considerable amount of time and so had an adverse effect upon train schedules and line capacity.

For the automatic line block, the double-track line has been subdivided into 16 line sections in both directions. These block sections are electrically isolated from adjoining sections by block joints. Each block section is designed as a track circuit. A current flowing along the rails of an unoccupied section energizes a track relay, which sets the signal and warning signal assigned to this section to the proceed position. If the rails of a section are occupied by a train, the track circuit is shorted, the track relay deenergized, and the associated signal and warning signal set to the stop position. With the automatic block the line is released for the next train as soon as the last train leaves the line section and the block signal of the next block section sets to the stop position.

The switching elements for each block section are accommodated in a relay box installed near the block signal. Expensive towers of the type required for the old line block are no longer necessary.

A cable for threephase current supplies the signals, track circuits and other switching facilities with a-c or d-c as required by way of appropriate transformers and rectifiers.

The automatic block terminates in front of each railroad station and begins anew behind it. For trains traveling along the main tracks without stopping at the station, the home and departure signals are switched to through-operation and then controlled from the respective train in the same way as block signals. Thus the station in this case likewise represents a block section. The all-relay interlocking can be adapted for temporary through-operation of this type without extra cost, so further increasing the capacity of the overall line.

The new signal systems installed along the line have given excellent service and all expectations have been fully met. Whereas the line capacity was previously 200 trains in 24 hours at the most, it has been increased by the new equipment to over 300 trains.

Besides this increase in capacity, the new signaling equipment has made it possible to cut down personnel requirements considerably.

Owing to the higher train speeds and the faster starting of trains, a further increase in capacity is to be expected when the line is electrified in the near future.

All-Relay Interlocking for Railroad Station on Franco-German Border

BY KARL HRDY

The border railroad station of Überherrn lies to the west of Saarbrücken on the Saarbrücken-Völklingen-Hargarten line. The station has separate French and German tracks and platforms, and the trackage was recently renovated. It was also decided to install a common signal cabin for the entire station (Figs. 1, 2). After a corresponding order was placed with Siemens & Halske, the signal cabin was designed, manufactured, installed and placed in service within the course of a year. Exceptional efforts were, however, necessary, and certain anomalies resulting from the border location of the station are reflected in the design of the signaling installation.

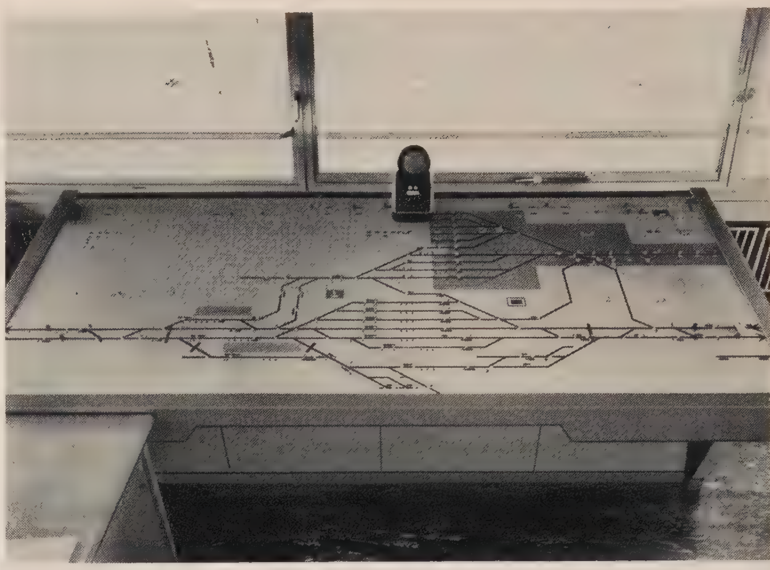


Fig. 1 All-relay interlocking at Überherrn border station

Überherrn is equipped for electric trains. The traction current used by West German trains has a frequency of 16 $^{2}/_{3}$ cps, while that for French trains is 50 cps. German track circuits for automatic vehicle-on-line or track-vacancy indication usually operate with a frequency of 100 cps. As this frequency could not be used in Überherrn without interference from the harmonics of the 50-cps frequencies of the traction current, a frequency of 125 cps was chosen.

Fig. 2 Geographical location of Überherrn station

Outbound lines from Überherrn were equipped with automatic blocks. Adaptation to French automatic block facilities was here necessary. A switching cabinet was installed at the border so that both signaling installations can be maintained separately.

The area served by the signal cabin includes a humpyard. To facilitate the duties of the dispatcher during peak traffic, shunting operations in this area are carried out by the yardmaster. For this purpose a control console has been installed on the hump, from where gravity shunting can be effected following clearance indication from the signal cabin. Up to 16 gravity runs can be stored simultaneously on pressing the buttons representing the track for which the invidual cars or groups of cars are intended. All other operations, including the timely actuation of the switches after the advance car has passed, are controlled by the automatic humpyard equipment. If necessary, the switches can also be set individually from the control console. The signaling installation includes 70 switches and derailers, 24 main signals and main shunting signals, 17 advance signals, 47 shunting signals, and 90 track circuits. 113 regular and auxiliary routes and 225 shunting routes can be established.

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SIEMENS U.D.C. 621.313.13-213.44

MARTIN REINHARDT

Standard Three-phase Induction Motors with "Increased-safety" Enclosures for Hazardous Locations

2½ pages, 1 figure, bibliography

Siemens Review XXVIII (1961) pp. 353 to 355

The recommendations of the IEC have led to the development of standard totally-enclosed three-phase squirrel-cage motors constructed in accordance with German Industrial Standards DIN 42673. The standard motors are co-ordinated according to size, shaft extension and output. In plants subject to explosion hazards frequent use is made of squirrel-cage motors with an enclosure of the "Increased safety" type. These motors have also been standardized. In the article a description is given of the special mechanical and electrical characteristics of these motors.

SIEMENS U.D.C. 621.516

HEINRICH ENGELS

ELMO Compressors for High System Pressures

3 pages, 5 figures, bibliography

Siemens Review XXVIII (1961) pp. 355 to 358

In the article the line of development is traced which leads from the vacuum pumps and fans produced during the early years of Siemens-Schuckertwerke via the Elmo pumps and compressors, designed specially for the chemical industry, to the more modern compressors for high system pressures.
The knowledge which has been gained on phenomena in liquid-ring compressors makes it possible to calculate without any great risk the pressures and throughputs of compressors, also where these are for very high discharge rates and special applications.

SIEMENS U.D.C. 621.516

GERT HECHT AND KURT WILLY MUGELE

Pressure Ratios and their Influence on the Design of ELMO Vacuum Pumps

2 pages, 3 figures

Siemens Review XXVIII (1961) pp. 358 to 360

For compression to atmospheric pressure it is possible with liquid-ring pumps to produce economically pressure ratios up to 7 per stage. In the case of single-stage ELMO vacuum pumps it is, however, possible to obtain pressure ratios up to approximately 25. A description is given of a newly developed vacuum pump of this type of construction. The ball valves can be removed after unbolting covers, and by removing further covers, the condition of the internal components can be checked.

SIEMENS U.D.C. 621.395.2:725.51

HEINZ-GÜNTHER GILLMEISTER

Hospital Press-to-Talk Intercom System

1 page, 2 figures

Siemens Review XXVIII (1961) p. 361

The hospital press-to-talk intercom system saves nursing personnel much hitherto unavoidable footwork and so allows them to devote more time to actual nursing activities. It is outstanding for its long life, dependability, easy handling and a variety of service facilities: emergency call circuit, night circuit, and slave stations connected in parallel with the master station so that calls unanswered at the latter can be picked up at slave stations.

SIEMENS U.D.C. 621.395.635.4

WALTER VILLMANN

ESK Translator for Direct Distance Dialing

2 pages, 3 figures, bibliography

Siemens Review XXVIII (1961) pp. 362 and 363

Operating with relays with noble metal contacts, the translator is a particularly economic central unit for alternate routing and zoning of calls dialed by subscribers. An account is given of the operating principle of the translator, which is outstanding for its speed, dependability and modest space requirements.

SIEMENS U.D.C. 681.14-523.8

HORST SCHUBERT AND WOLFGANG WEISSER

Siemens Data Processing System

3 pages, 3 figures

Siemens Review XXVIII (1961) pp. 364 to 367

At the 1961 German Industries Fair in Hanover the data processing system 2002 was displayed as the heart of a large composite system for integrated data processing. Layout, input and output facilities and a typical example for the commercial application of the equipment are described.

SIEMENS U.D.C. 621.791.736.3

FRIEDRICH CZECH

Projection Welding — the most Rational Method of Resistance Welding

4½ pages, 9 figures, bibliography

Siemens Review XXVIII (1961) pp. 367 to 371

Projection welding is a resistance welding process. The object of the projections is to concentrate the welding current and the electrode pressure at the point where welding is to take place. The process is particularly suitable for the mass production of drawn or stamped articles. Its advantages lie in the speeding-up of the operation, the reduction of the number of bad welds, lowering of the production costs, and in the production of clean and reliable welded joints. A description is given of the basic principles of projection welding single-phase and three-phase projection welders and of a few typical applications.

SIEMENS U.D.C. 621.317.39:621.316.7

HEINZ KRONMÜLLER

TELEPERM Transducers

3½ pages, 5 figures, bibliography

Siemens Review XXVIII (1961) pp. 371 to 374

In view of the multitude of variables and ranges of measurement which are nowadays required to be dealt with, the function of transducers to convert the measured and controlled variables into a uniform signal range necessitates a system of devices tuned carefully one upon another This system and its component units are treated in detail after an introductory description of the different modes of operation.

SIEMENS U.D.C. 621.31:631.81

OTTO JANISCH AND KARL WEBER

Electrical Equipment for Fertilizer Factories

5½ pages, 6 figures, 3 tables, bibliography

Siemens Review XXVIII (1961) pp. 375 to 380

In the erection of fertilizer factories the requirements to be met are those of continuous chemical processing. This must be taken into account when considering the first costs, operating costs and dependability of the power generating and distribution plant and also other equipment such as motor drives.
The article contains data on the design of power distribution systems and on the selection of drive motors. A report is given on the main points to be noted in planning and design.

For cutting out and pasting on index cards

SIEMENS U.D.C. 621.396.932:621.396.61

WERNER GAWLICK

Transmitter Technique for Shore Radio Stations

4½ pages, 5 figures

Siemens Review XXVIII (1961) pp. 380 to 384

The paper outlines the applications and equipment of shore radio stations serving for ship-to-shore radiocommunication. It also gives an idea of future development aimed at the introduction of full-automatic transmitters with a view to reducing requirements for trained operating personnel.

SIEMENS U.D.C. 656.257:621.398

JOSEF GANSEFORTH

Railroad Line Capacity Increased by Automatic Blocks

1 page, 1 figure

Siemens Review XXVIII (1961) p. 385

The important Gießen-Friedberg route carrying North-South-bound traffic was hitherto controlled and safeguarded by mechanical means. Siemens & Halske have now equipped this route with several pushbutton type all-relay interlockings and replaced mechanical by automatic route blocks. It has in this way been possible to increase line capacity from 200 to 300 trains per day.

SIEMENS U.D.C. 656.257:621.398

KARL HRDY

All-Relay Interlocking for Railroad Station on Franco-German Border

1 page, 2 figures

Siemens Review XXVIII (1961) p. 386

Siemens & Halske have supplied a central all-relay interlocking for the frontier railroad station of Überherrn on the line between Saarbrücken and Haargarten. The design of the interlocking system and the special situation arising due to the frontier location of the railroad station are described.

SIEMENS